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ARMY ORDNANCE

VOL. V WASHINGTON, D. C., SEPT.-OCT., 1924 No. 26

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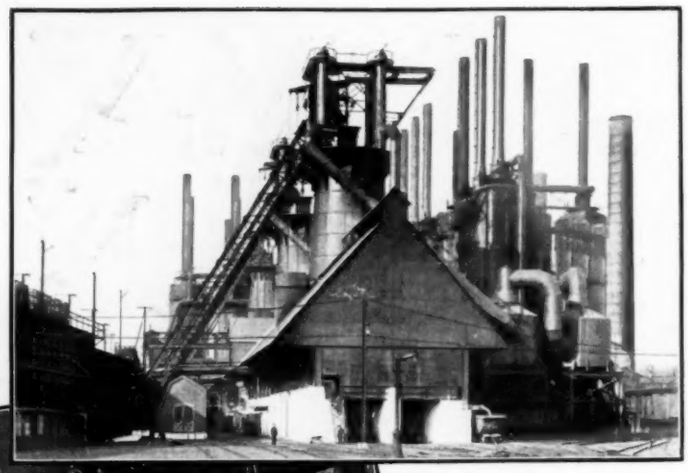
~THE·JOURNAL·OF·THE·ARMY·ORDNANCE·ASSOCIATION:~

Sixth Annual Meeting, Aberdeen Proving Ground, October 3, 1924

At right: Blast furnaces, converting ore into iron. Below: Open hearths, where the iron is converted into steel.



Below: 14,000-ton hydraulic forging press in operation.

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ARMY ORDNANCE

THE JOURNAL OF THE ARMY ORDNANCE ASSOCIATION

Pledged to Public Service in Effecting Industrial Preparedness for War as Our Strongest Guarantee of Peace

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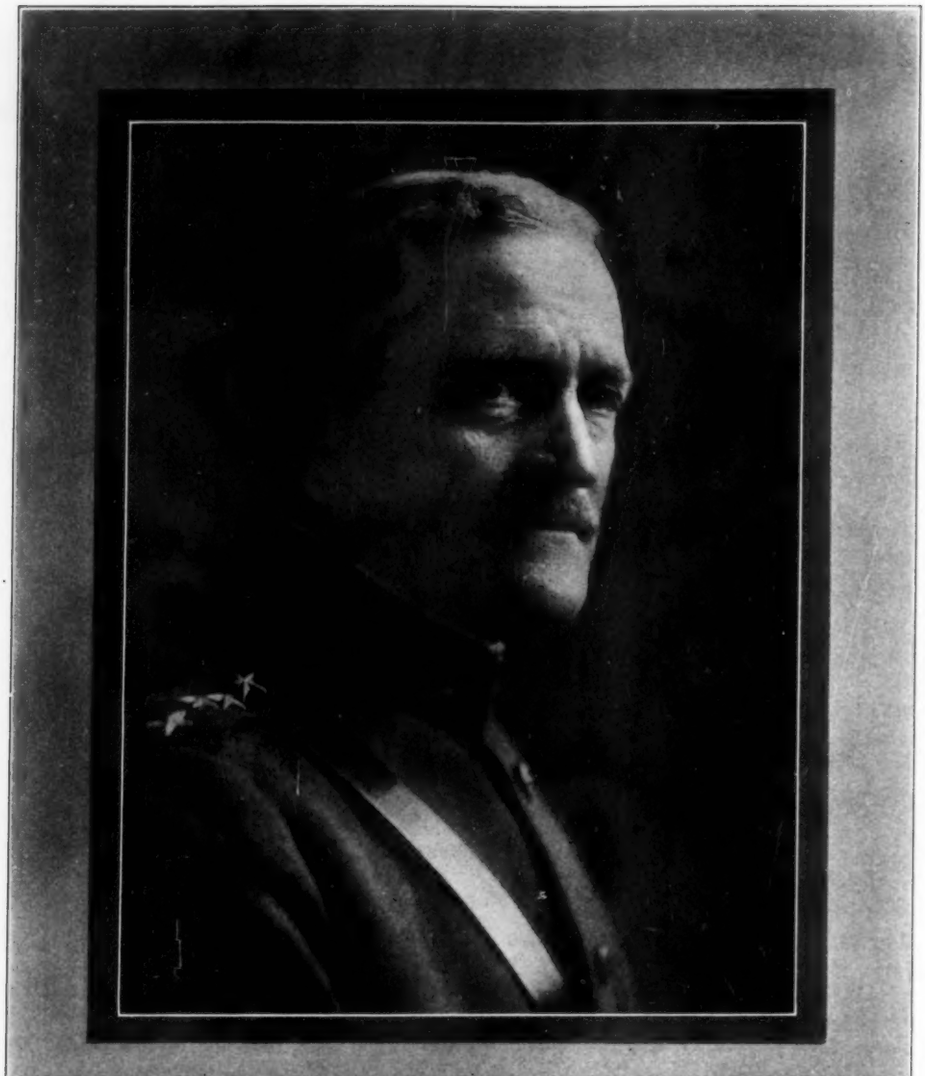


John J. Pershing

General of the Armies, U. S. A., Retired

"With no malice, but with forethought that marks the wise man, we shall, I hope, look at ourselves in time of fair weather to see how we might fare in a storm."

—*General Pershing*

September 12, 1924

The Sixth Annual Meeting

of the

Army Ordnance Association

will be held at

The Aberdeen Proving Ground, Friday, October 3, 1924

The American Institute of Chemical Engineers
The Institute of Makers of Explosives
The National Defense Section of the American Society of Mechanical Engineers

and

Local Sections of the American Chemical Society
have been invited to attend

LATEST developments in ammunition, explosives, guns, gun carriages and automotive equipment will be shown. The chemistry of warfare will be emphasized and the Chemical Warfare Service will demonstrate some of its latest achievements. It is hoped that this will be one of the largest and most interesting meetings ever held by the Army Ordnance Association. The tentative program is outlined below. The complete detailed program will be mailed to members on or about September 22nd.

Tentative Train Service

(Trains as numbered will stop at Aberdeen, October 3. Consult timetable for possible change in time.)

GOING

Southbound—	Baltimore & Ohio Train No.	Time	Pennsylvania Train No.	Time
Leave Philadelphia	15	7:45 AM (Wayne Junct.)	405	7:20 AM (Broad St.)
		8:00 AM (24th & Chestnut)	417	10:30 AM (Broad St.)
Arrive Aberdeen	15	9:26 AM	405	9:06 AM
			417	12:17 PM
Northbound—	**Baltimore & Ohio**		**Pennsylvania**	
	Train No.	Time	Train No.	Time
Leave Washington	4	7:15 AM	110	7:25 AM
			406	11:45 AM
Leave Baltimore	4	8:12 AM (Mt. Royal)	110	8:23 AM
			406	12:50 AM
Arrive Aberdeen	4	8:51 AM	110	9:05 AM
			406	1:46 PM

RETURNING

Northbound—	Baltimore & Ohio Train No.	Time	Pennsylvania Train No.	Time
Leave Aberdeen	22	*5:37 PM	412	*4:52 PM
	20	9:05 PM	134	9:00 PM
Arrive Philadelphia	22	7:00 PM	412	6:55 PM
	20	10:40 PM	134	10:00 PM
Southbound—	**Baltimore & Ohio**		**Pennsylvania**	
	Train No.	Time	Train No.	Time
Leave Aberdeen	9	8:20 PM	413	6:29 PM
			131	9:15 PM
Arrive Baltimore	9	9:03 PM (Mt. Royal)	413	7:10 PM
			131	9:56 PM
Arrive Washington	9	10:00 PM	413	**8:20 PM
			131	10:55 PM

Note: For trains marked * Passengers should leave Proving Ground on "Shop Train" at 4:39 P. M.
Passengers on train marked ** change in Baltimore for Washington.

Arrangements are now being made whereby members may secure reduced fares to attend this meeting. Certificates will be mailed to all members which will enable them to purchase a round-trip ticket from the local agent at any point in the United States at the price of one and one-half single fare. The exact territory in which the rates will apply will be announced in the detailed program which will be mailed to all members.

Arrangements are also being made for a special train of Pullman sleeping cars which will leave the Pennsylvania Station, New York City, shortly after midnight, October 3rd, and will arrive at Aberdeen in time for breakfast. Complete details as to schedule, reservations, etc., on this special train will also be announced in the program which will be mailed to all members.

Tenative Program

10:00 A. M. Arrive Proving Ground.

10:15 A. M. Arrive Plate Range.

Firings with 3-inch Antiaircraft Gun by Coast Artillery Corps Battery against target towed by airplane.

Fire 16-inch Gun, Model 1919 MII, on Barbette carriage.

Emplace 14-inch Railway Gun, Model 1920, on permanent emplacement from traveling position.

Drop two 300-lb. bombs on water.

11:15 A. M. Leave Water Battery.

11:25 A. M. Arrive Aviation Field.

Inspect exhibit of foreign and domestic bombs.
Inspect exhibit of available airplanes.
Inspect Dirigible TC-2.
Lay smoke screen with Martin bomber.

12:15 P. M. Arrive Visitors' House.

12:30 P. M. Lunch.

1:30 P. M. Leave Visitors' House.

1:35 P. M. Arrive Main Front.

Inspect exhibit of Automotive Equipment.

Tanks

Medium Tank, Model 1921.
Medium Tank, Model 1922.
Mark VIII Tank with Stroboscope.
6-ton Tank capable of laying smoke screen.

Tractors

2½-ton, Model 1920.
2½-ton, Model 1918.
2½-ton, Model 1918 with increased cooling system, including coils for cooling crank case oil.
2½-ton, Model 1918, with Liberty truck engine.
Holt T-35.
Pavesi.
Fordson with Hadfield-Penfield Adapters.
Fordson with Full Crawler Attachment.
Fordson Tractor with standard wheels.
5-ton Artillery Tractor.
7½-ton Corps Artillery Tractor.
10-ton Artillery Tractor.

Motor Carriages

75-mm. Gun Motor Carriage, Mark VII.
75-mm. Gun Motor Carriage, Mark VI.
4.7-inch Gun Motor Carriage, Model 1922.
155-mm. Gun Motor Carriage, Model 1921.
155-mm. Gun Motor Carriage (Christie).

Cross Country Vehicles

6-wheel Militor Truck.
Dodge Truck with Chase Track.
Nash Truck with Caterpillar Adapters.
Roadless Mack Truck.
Christie Mack Truck.
Cargo Cart, Model 1923.
5-ton Tractor Caisson, Model 1923.
Ford Reconnaissance Car, Model 1923.

2:00 P. M. Aircraft Armament, Smoke Bombs, etc.

Drop two 300lb bombs on land.
Drop smoke bombs.
Smoke curtain by use of smoke candles.

2:15 P. M. Field Artillery Maneuver.

Field Artillery battery to maneuver, register on target with shrapnel and put down smoke barrage.

2:45 P. M. Small Arms Exhibit.

Fire .30 caliber machine gun against toy balloons using tracer ammunition for control of fire.
Fire .30 and .50 caliber armor-piercing bullets against tank plate.
Have exhibit of thin armor plate.
Fire white phosphorus rifle grenades.
Fire ground type pyrotechnics.
Exhibit of small arms powder and fixed ammunition.

3:15 P. M. Mobile Artillery.

Firings will be made with the following:
37-mm. Super-sensitive fuzes.
75-mm. Pack Howitzer.
75-mm. Gun, Model 1920.
105-mm. Howitzer, Model 1920.
4.7-inch Gun, Model 1921.
155-mm. Howitzer, Model 1920.
155-mm. Gun, Model 1920.
8-inch Howitzer, Model 1920.
3-inch A. A., Model 1920.
4.7-inch A. A., Model 1920, with muzzle brake.
75-mm., Model 1897, with black, service and flashless powder charges.
3.3-inch stability firing through thick distribution of cardboard screens.
Outline of trajectory.
Following exhibits will be shown:
Obsolete American field guns.
Exhibit of foreign guns used in World War.
Exhibit of cannon powders.

4:00 P. M. Demonstration of Automotive Equipment itemized above.

Exhibit of smoke screen from tank.

4:30 P. M. Visit Museum.

Exhibit of damaged guns, impressions showing pastilles, etc.

5:00 P. M. Business Meeting of Army Ordnance Association.

6:00 P. M. Supper.

8:00 P. M. Night Firings, Main Front.

.30 and .50 caliber tracer ammunition.
Ground pyrotechnics.
Airplane signals and flares.
3-inch Field Gun with night tracers.
3-inch A. A. with Chelsea mechanical time fuzes.
Comparative firings of service and FSNH powders.

RESERVATION OF MEALS

Unless you mail this request for reservation of luncheon and dinner to the Proving Ground by Wednesday, October 1, 1924, no guarantee can be made that meals will be available for you. Since all food must be shipped from Baltimore by the caterer, it will be impossible to refund money for meals once ordered.

The Commanding Officer, Aberdeen Proving Ground, Maryland:

I desire to attend the Sixth Annual Meeting of the Army Ordnance Association to be held at the Proving Ground on Friday, October 3, 1924, and I request that you reserve luncheon and dinner for me on that day. I am enclosing my check for three dollars ($3.00) drawn to your order.

Please send Meal Ticket to:

_____
(Member A. O. A.)

_____
(Address)

The Significance of National Defense Day

By

MAJ. GEN. R. L. BULLARD

The following address by General Bullard was delivered before the Southern Club of Columbia University. In our opinion, it is one of the strongest, most logical and most concise pronouncements on the subject that has yet appeared. So many absurd statements have been made recently as to the meaning of Defense Day that General Bullard's address, coming as it does from one who was in large part responsible for the heroic achievement of the American Forces in the World War, should convert and convince those who have opposed this practice mobilization of the nation.

FOUR years ago our Congress, with that best of sights—backsight—took our National and World War experience and embodied it partially in a law of National defense. One of its provisions looked to bringing men quickly into the military service in cases of great emergency. The method was, I say, based upon our own National and war experience. It provided the measures that would be taken by the authorities of each locality, a thoroughly democratic way. It authorized committees or boards to be appointed by the Governor of each state, in each region thereof, to bring people together in such emergency, in the Regular Army, in the National Guard, and in the Reserve.

General Bullard

This law has been now upon our statute books for four years without test or trial of any sort. It has recently been proposed by the War Department, and sanctioned by the President, to make a peace-time and peaceful test of the law, to show our people the first faint steps that they would take in case we should ever come to a war; and this is proposed to be had in a time of profoundest peace and to be wholly voluntary.

Along with this little test we are to give (as there always come in time of war) popular demonstrations of patriotism and good will toward the country's call. Patriotic societies are invited to take part in public demonstrations.

All of this, I say, whether by soldier or civilian, is to be entirely voluntary upon the part of the citizen and the public and without cost to the Government, to last a half hour, an hour, or two hours or three hours as people desire. There is nothing compulsory, there is nothing boastful, there is nothing threatening whatever in its nature or purpose. It is aimed at no particular nation and has no other idea than self-instruction, just as children are drilled in the school in the method of saving themselves in case of fire in their schoolhouses, or as crews of ships on every voyage are drilled in the work of saving themselves and passengers in case of wreck or fire.

Upon the announcement of this commendable and worthy plan, a great outcry has been raised by a few brain-sick hysterical pacifists. It would be, according to them, a "militaristic gesture," a "flaunt in the face of other nations," a "threat of war," and whatnot, which would arouse and offend other nations. I assure you that it is so trifling and peaceful a thing that any nation that would regard it as a threat of war would be silly fools.

If any nation feels so inclined, and we have not heard of a single one who does feel so inclined, to look upon this as a threat of war or a militaristic gesture, such a nation is throwing a fit; and if it really takes this little trial as threat of war, or if it resents this little test of the National defense law, then I, for one, say we should have gone very much further and made a real show of war out of it, because such resentment would be the resentment of the robber and the thief against the man who locks his door or guards his property. For the Government to yield to such foolish outcries and give up this little harmless test and abandon its law and method of defense would be just like abolishing the police because thieves and robbers found them disagreeable, and threatening to the thieves' and robbers' business.

The people who are making this hysterical outcry are, I say, of the pacifist group whom, during the war, we learned to know and curse as the worst enemies that the nation ever had. By such hysterical talk before the war they brought us up to and into the war unprepared, and made us lose always two and sometimes three times as many men as our Allies fighting at our side. They made it necessary for us to rely upon Great Britain's navy to stand between us and the enemy until we were prepared to fight. It amounted to a British naval protectorate over this great nation. However kindly that was, do we, as Americans, want it kept up or repeated? They cried out so vociferously against preparedness that our nation finally went into war almost without either arms or ammunition and we had to be supplied largely by our Allies. They cried out so persistently against all preparedness that we had to decide upon methods of gathering soldiers, organizing, training, equipping, supplying and moving them all after we had declared war and even after we had in a small way begun to fight. They made us lose nine months in a crisis. These were the works of pacifists, of the people who now oppose the Defense Day Test.

I am sure that the great majority of us, the overwhelming majority, intend that this nation shall be adequately defended and properly prepared for any emergency of war. There is but one way to be so prepared and that is to practice at least a little in time of peace what we will be called on to do in time of war.

Our people, in their tolerance of others' views and wishes, have fallen into the habit of permitting any vociferous minority to dictate to us. The pacifists and objectors in this matter of the observance of a National Defense Day are unquestionably the vociferous minority. The great bulk of us do not mean to give up tamely our part or property in the world or to apologize to other nations for keeping our part. Are we then going to let these pacifists again, for any future war or difficulty, as they did for the last one, dictate to us a policy of National defenselessness and unpreparedness? I cannot believe it.

Industry Starts Defense Test

Judge Gary of New York Ordnance District Advisory Board in Conference With Army Officials

In order to test industrial preparedness within the New York District, army officers and captains of industry under the leadership of Judge Elbert H. Gary started a dress rehearsal of all steps short of actual manufacturing, which must be taken to start in motion the industrial machinery necessary for National Defense. Ordnance and airplanes as being non-commercial and therefore, the most difficult to procure, received first attention.

On receipt of telegraphic orders from Washington, Colonel James L. Walsh—Chief of the New York Ordnance District, who is also acting as Chief of the Eastern Air Service District—communicated with Judge Gary, Chairman of the United States Steel Corporation and head of the Advisory Board, who went at once to the Army Building, 39 Whitehall Street, for further information as to the emergency assumed for purposes of the test. Other members of the Board, who reported at the District Office, included Guy E. Tripp, Chairman, Westinghouse Electric & Manufacturing Company; Samuel McRoberts, President, Metropolitan Trust Company, and James G. Harbord, President, Radio Corporation of America.

As soon as the Advisory Board had assembled, Colonel Walsh outlined briefly the assumed situation as being a major emergency which would apparently call for the complete utilization of the full man-power and the entire industrial resources of the country, and stated, "Based upon our World War experience, the New York District is confronted with a possible industrial effort within one year equivalent to building a Panama Canal —which took ten years to complete.

As to the size of the job we are facing, during the period from March 1, 1918, to February 1, 1919, payments of more than $500,000,000 were actually made in the New York Ordnance District under World War contracts. Due to the painstaking computation of requirements which has recently been completed under the direction of the Assistant Secretary of War, probably one-third of this can be saved by eliminating over-ordering. This leaves us a $330,000,000 job for the year ahead—equivalent to building another Panama Canal.

If our plans had been fully worked out so that each manufacturer knew exactly what he had to produce, how many and how soon, we could undoubtedly further reduce the total cost of the job. As it is, we must do the best we can. Potential manufacturers of ordnance and aviation material have been asked to confer with Government representatives beginning at 9:00 A. M., September 12th, at the Engineering Societies' Building, and to join in a general meeting at 3:00 P. M. on that day under the auspices of the local sections of the following engineering societies:

Army Ordnance Association,
American Society of Civil Engineers,
American Institute of Mining and Metallurgical Engineers,
The American Society of Mechanical Engineers,
American Institute of Electrical Engineers,
Society of Automotive Engineers,
American Chemical Society.

In referring to the meeting, Judge Gary, Chairman of the Advisory Board, stated that it was one of the initial steps in a week's program intended to determine how well New York is prepared to assume its share of the tremendous industrial burden which would devolve upon it in emergency. Continuing he stated: "We realize that we still have a very great task before us, one that might seem well-nigh impossible, but for the fact that so much has already been accomplished as to indicate the probability of complete success within the next four or five years.

"Today we learned just how far the work has progressed in the New York District, and what pressing problems the Advisory Board could be of assistance in solving, if the assumed emergency really existed. We adjourned to meet again on September 12, 1924.

Limiting Factors of Our Army in War

By

HERMAN SCHNEIDER

Dean Schneider

UNDER normal peace conditions there are seven limiting factors of production, as follows: 1, Demand; 2, Fluid capital; 3, Transportation; 4, Labor; 5, Raw material; 6, Equipment; 7, Power.

For example, at the present time, Demand is a limiting factor; factories are not operating to capacity because of lack of orders for their goods. Fluid capital is plentiful; the interest rate is low and money is easily obtained. All of the other factors are available in ample quantities — there is plenty of labor, railroads can carry the goods, and there is ample raw material, equipment and power.

In 1919 the conditions were very different. Demand was great, and as demand increased, the other factors became limiting ones. The manufacturers could not get cars, and shut-downs of factories were frequent on this account. It became more and more difficult to obtain fluid capital and finally the Federal Reserve Bank shut down on expansions. Orders "pyramided," since the manufacturer had difficulty in getting his equipment and raw materials. Thus if a manufacturer wanted one machine tool, he ordered two or three, hoping to get one. The machine tool builders, knowing the difficulty of getting castings, ordered more than they needed, hoping to get enough. Finally the structure toppled, since the whole condition had become artificial.

The principal limiting factor was transportation and this limitation of transportation brought about the "pyramiding" of orders. To get a clear picture of the transportation situation, let us imagine that this room is a factory. The factory must have aisles to carry the raw materials to the machines and to take the finished products away from them. There is a most efficient width of aisle, namely, that which will supply the machine with raw materials and take the finished products away without congestion. If the aisles are too narrow, machines will be idle on account of non-delivery of material and the inability to take away the products that are finished. The more the aisles become cluttered, the less material is transported, until finally the aisles become choked and machines have to shut down almost entirely until the aisles are cleared. Under these circumstances, no new material can be started through the aisles.

Now, the United States is a factory, and the railroads, rivers, and highways are the aisles of that factory. The basic point to be understood is that we can manufacture what we can carry in raw materials and in finished products, and no more. In other words, the manufacturing capacity of the United States is what the railroads and other highways can carry in raw materials and finished products.

In war time we have a huge demand and the government can command all the fluid capital necessary. Therefore, during a war we have five limiting factors, namely: 1, Transportation; 2, Labor; 3, Raw material; 4, Equipment; 5, Power.

An analysis made in 1917, during the World War, showed that of all of these, transportation was the actual limiting factor; it follows again, as indicated above, that we can manufacture during a war what we can carry (on the railroads primarily) in raw materials and finished products, and we cannot manufacture more than this. The maximum army which the United States can put in the field is the maximum army which it can equip, and the maximum army it can equip is the maximum army which any limiting factor will permit it to equip. It follows, then, that the size of the army which the United States can put into the field is governed almost entirely by the amount of material which the railroads can carry—this is the limiting factor.

In 1917 the flow of materials was primarily eastward. It was not long until congestion appeared. Outline maps

of the United States, such as are used by the Weather Bureau, were prepared, with each railroad yard represented by a red dot. The congestion in each yard was shown by an arrow backward from the yard, westward. This arrow lengthened week by week in a degree which could be indicated by a curve and, therefore, by a mathematical formula. About the first of December, 1917, a curve was plotted and the formula worked out. It was assumed that when the arrow from one yard reached backward to the next yard, complete congestion would take place, and since the rate of increase in congestion was known mathematically, it was not much of a trick to prove that complete congestion would occur about February 1, 1918. A complete congestion of the railroads meant exactly what a complete congestion in factory aisles would mean, namely, a stoppage of materials entering the aisles or, in the case of the United States, a fatal congestion of the railroads.

As a matter of fact, the actual congestion occurred on the seventeenth of January, at which time the coal commissioner issued an order shutting down all the factories of the United States for one week and for one day a week thereafter until the congestion was cleared. In other words, we had the unthinkable situation of shutting down our factories in the middle of the World War!

Production Greater than Transportation

It was apparent from the studies made at that time that the railroads could not carry all that the factories could make, working at the speed at which factories ought to work during a great war. It was assumed during the war that there was a shortage of labor. Manufacturers were making great inducements to workmen to leave plants in which they were employed and go to their own plants. As a matter of fact, there was ample labor to do the amount of work which the railroad situation would permit us to do, and if the manufacturers had made a careful analysis of production, there would not have been the hectic scramble for workers which actually occurred.

Another limiting factor during the war was coal. This limiting factor, however, was not due to any difficulty in mining the coal, but in transporting it. Here again the situation was one of transportation. The difficulty in getting most of the raw materials was not one of digging them out of the earth, but of transporting them. There were deficiencies in equipment, to be sure,—for example in the manufacture of electrical cranes, but in the main the equipment situation could have been solved easily had there been sufficient transportation.

A Typical Case

The number of economic problems of a definite practical nature which were possible of solution by reason of a scientific knowledge of the factors involved may be indicated by the following:

One of the eastern cities came to the authorities at Washington and asked for eight million dollars' worth of additional houses for workmen. Their argument was that so many orders had been placed in their town that more workmen were needed and they did not have places to house them. An examination of the transportation facilities showed that there was already a serious congestion in handling the material going into that city and on numerous occasions the workmen already were idle by reason of nondelivery of material. It was evident that if additional workmen were put into that town, no more actual work would be gotten out of it for the very simple reason that the railroads could not carry any more in raw materials and finished products than they were already carrying. It was evident, further, that the material necessary for eight million dollars' worth of houses would have to be added to the railroad congestion and so hampered the transportation of war material still more. The net result would have been fewer hours of work per week for the workers already in the city. Consequently, the request was declined.

It is not a criticism of any one in particular to say that no thought of railroad congestion entered into the placing of war orders. If forgings were needed, the orders were put into an industry, usually in the seaboard states, which had experience in making forgings. The industries accepted these orders with the hope that they could get their raw materials and ship their finished product. It was not until an analysis of the transportation situation showed the impossibility of getting these orders out of the industries into which they were placed that a recasting of the orders was undertaken; more orders were placed westward and new facilities for production were similarly created west of the more congested district. One of the departments, for example, had a plan to build a huge plant at Midvale. However, when it was shown that the conditions at Midvale were already congested, a location west of Pittsburgh was chosen. I have been told that in some cases it was easier to ship goods from Pittsburgh to New York via New Orleans by water than from Pittsburgh to New York direct by rail. My recollection of the transportation situation would indicate that this was true. Certainly, under present conditions, if there were a similar congestion, it would be much easier to ship from Cincinnati to New Orleans by river and then by boat to France than to ship from Cincinnati to New York and by boat to France.

Transportation still the Limiting Factor

Obviously, any scheme of preparedness should take into account the limiting factors. If we were confronted by a war today, transportation would again be the limiting factor. It is worth reiterating that we could put in the field as big an army as we could equip and the army which we could equip would be established by the limiting factor of transportation. This shows the necessity of a thorough study of the transportation situation for war time purposes, as well as for peace time purposes. The placing of orders should depend, to a certain extent, upon transportation possibilities as well as upon contiguity to raw materials. The importance of water-ways and highways cannot be overestimated in this study. During the war, many of the highways, because of their light construction, broke down under the heavy traffic. Whether or not the water-ways were used to their full capacity I have never known, but certainly at the present time some of our water-ways are in condition to carry more than was carried upon them during the war.

The factors entering into this discussion are so clear cut as to make possible an analysis of the whole problem of preparedness to obtain the maximum achievement. The factors are inter-related; that is to say, the shortage in coal and in raw materials was dependent primarily on transportation.

A measurable solution which may not be absolutely accurate is much better than no solution at all, or than any plan which fails entirely to take into account the economic factors which limit production under peace time and war time conditions alike.

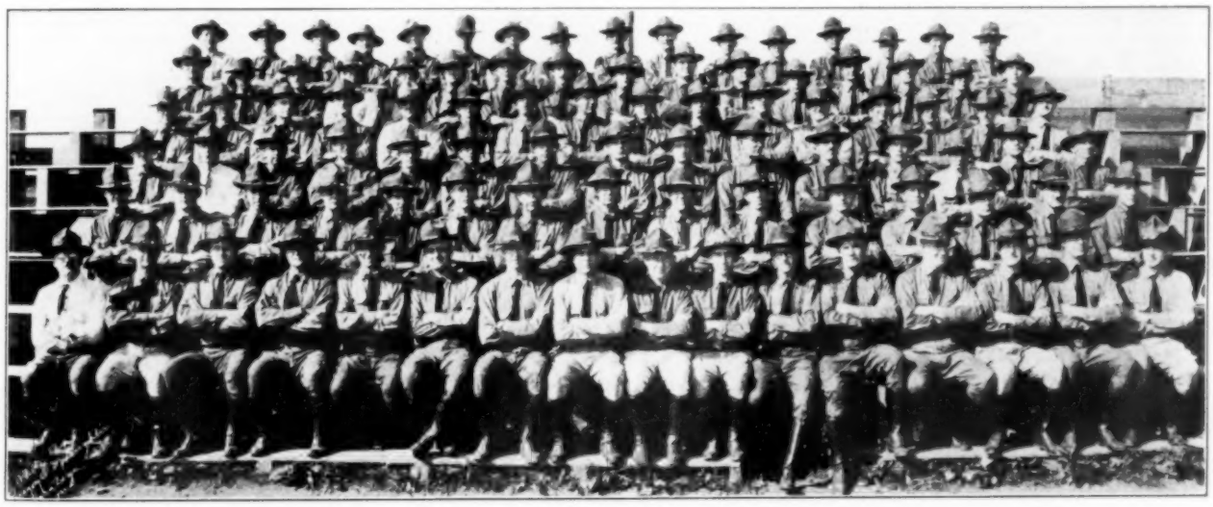
Ordnance Reserve Officers Training Camps, 1924

The Aberdeen Camp

By

Maj. Henry Erwin, Ord. O. R. C.

THE first training camp of the Branch Assignment group of the Ordnance Officers Reserve Corps was held at Aberdeen Proving Ground, Maryland, from August 3rd to August 17th. The officers in charge of the camp and who were largely responsible for its success were Camp Commander Col. Wm. H. Tschappat, Commanding Officer at the Proving Ground; Director of Training, Maj. John A. Brooks, Jr.; and Director of Ordnance Training, Maj. C. H. Bandholtz. There was in attendance a class of 90 officers, ranging in rank from second lieutenant to colonel.



Ordnance Reserve Officers in Attendance at Training Camp, Aberdeen Proving Ground, August, 1924

Brig. Gen. Joyes at the beginning of the series of lectures, which were delivered to the officers in attendance, stated that the purpose of the camp was to provide a broad and comprehensive setting-forth of all of the activities of the Ordnance Department and of their relations one with another, primarily, so that those officers who were during the war necessarily serving in limited fields should aequire the broader view of the relation of their own activities to those of the Ordnance Department and of the Army as a whole. In meeting the aim of those who provided the instruction work of the camp, the results seem to have well merited their excellent foresight.

Upon arrival at the Proving Ground the officers were assigned to barracks, roughly graded into groups of lieutenants, captains, and field officers. A mess was provided that was excellent in the variety of food furnished. A medical examination was required of all in attendance; and medical attention was provided at the Proving Ground hospital for any who needed it.

When once the camp was under headway each day was filled with varied duties. While the first call was at 6:30 a. m., most of the officers had risen at 5:30, except a few who were adepts at getting under the wire at the last moment and who postponed their shaving until the end of the day. But the early ones paid their penalty by having to retire at 9:00 p. m. The lights were usually out by 9:30, and one dropped off to well merited sleep unmindful of the surrounding chorus.

The method of instruction adopted and so successfully carried out was three-fold: physical, mental, and visual or practical. The physical instruction embraced setting-up exercises and military training. The mental instruction consisted of a series of lectures on various aspects of Ordnance and its matériel. The visual or practical instruction consisted of demonstrations conducted by Regular Army officers and civilian specialists, largely in practical exemplification of the lectures previously given. In many of the demonstrations the students performed the work itself.

The physical side of the training started off the day's work before mess in some not too strenuous setting-up exercises which served as a tonic for the day. After breakfast there was given nearly an hour's drill, which during the camp extended through the evolutions of the school of the soldier, squad, platoon, and company. At some time during the period each student was given a

chance to drill his platoon. One of the novel features of the drill was the method of having each platoon of the company repeat in unison the proper command of the movement being executed. This military training was particularly advantageous to those officers in whose assignments during the War there was very little military practice.

Enjoying a Dip in the Chesapeake

The lectures offered in the course of instructions covered a very wide field, in the endeavor to circumscribe all of the varied activities of the Ordnance Department. The talks were terse and interesting and were usually accompanied with stereoptican and moving pictures. A typewritten summary in the form of questions on the work was given to the students, which was very valuable for the purpose of review. The following is a list of the lectures presented:

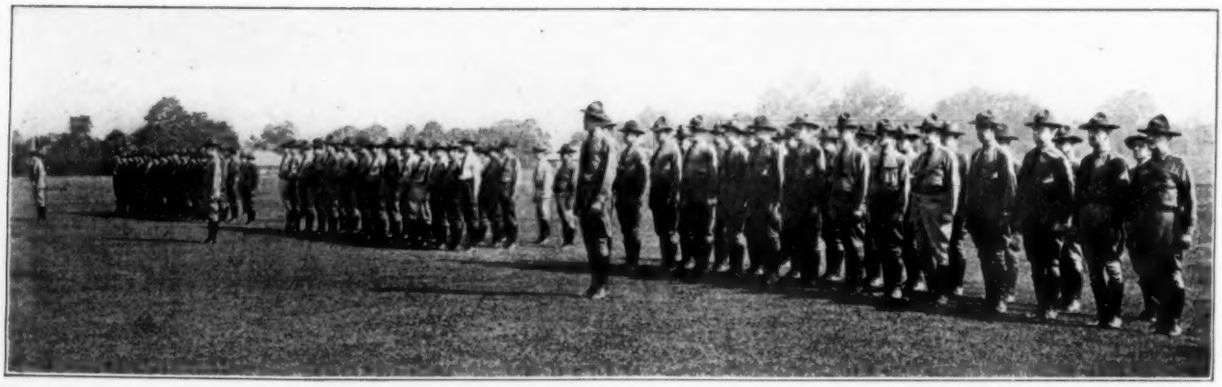
"The Ordnance Department and the Reserve Officer."
Brig. Gen. J. W. Joyes, Ord.
"Organization of the Ordnance Department."
Col. Wm. H. Tschappat, Ord.
"Seacoast Artillery."
Maj. G. M. Barnes, Ord.
"The Antiaircraft Gun Problem."
Maj. G. M. Barnes, Ord.
"Manufacture and Development of Smokeless Powder."
Col. C. G. Storm, O. R. C.
"Fire Control Instruments."
Maj. J. B. Rose, Ord.
"Design of Field Artillery Carriages."
Maj. J. B. Rose, Ord.
"Armament of Infantry."
Maj. Herbert O'Leary, Ord.
"Field Service Activities."
Maj. H. R. Kutz, Ord.
"Manufacture and Development of High Explosives."
Col. C. G. Storm, O. R. C.
"Storage of Explosives."
Capt. Maxwell F. Barnes, O. R. C.
"Development of Automotive Equipment."
Maj. A. B. Quinton, Ord.
"Bombs and Bombing."
Maj. W. A. Borden, Ord.
"Ordnance Property."
Maj. John A. Brooks, Jr., Ord.
"Industrial Mobilization."
Capt. MacMorland, Ord.

The practical side of the instruction consisted of demonstrations given on the main front where it was possible to fire the different types of ordnance, in the machine shop, and in various other buildings designed for specialized activities. Every effort was made to have the reserve officers conduct the demonstrations themselves, so that all of the practical experience that could be gained from actual contact with matériel could be had. The men enjoyed this work exceedingly, for with weighing powder, filling shells, making pressure tests, stringing wires for velocity tests, firing field pieces, machine guns and rifles, taking apart guns and recuperators, driving tanks and tractors, they had experiences that many had not had before and accordingly learned much.

In these demonstrations practically the entire terrain of the Proving Ground was covered, either on foot, in buses, by train, or by rides on trucks, tanks and trailers, not to mention airplanes. The various activities of the post were visualized by visits to the machine shops, general and ammunition storage depots, firing ranges, targets, armor plate butts, airplane hangers, and testing and assembling shops. In all of these places something was always done by the students themselves that served to impress on them the technique and scope of ordnance work.

The following is a list of the demonstrations given:

Inspection trip around the Proving Ground.
Maj. C. H. Bandholtz, Ord.
"Seacoast Artillery."
Maj. V. L. Borden and Maj. C. H. Hamilton, Ord.
"Establishment of Charge, Pressure, Velocity Curves."
Capt. E. L. Ford, Jr., Ord.
"Acceptance Tests of Ammunition."
Capt. E. L. Ford, Jr., Ord.
"Trench Warfare Material."
Capt. F. C. Shaffer, Ord.
"Antiaircraft Artillery."
Lieut. L. Meyns, Ord.
"The Service Rifle and Machine Guns."
Capt. W. C. Trumbower, Ord.
"Small Arms Ammunition."
Mr. J. C. Gray, Ord. Dept.



The Three Platoons at Drill, Aberdeen Camp

Scenes at Reserve Officers Training Camp, Aberdeen, 1924

1. Third Platoon operating 155-mm. Trench Mortar. 2. The Martin Bomber in which many of the officers made trial flights. 3. Demonstration of 5-ton Holt Tractor drawing 4.7-inch Gun. 4. Demonstration of Mark IX 155-mm. Gun Tractor. 5. 4.7-inch Gun on Christy Mount. 6. Trailer with Colonel Wagner, Colonel Storm and Major McQuigg and others drawn by 2½-ton Tractor. 7. The Mark VIII Tank. 8. The 6-inch Seacoast Rifle. 9. Maneuvering 10-ton Holt Tractor with 155-mm. G. P. F. Gun.

"Tests of Small Arms Ammunition."
Capt. W. C. Trumbower, Ord.
"Mobile Guns and Carriages."
Lieut. R. Z. Crane, Ord.
"Ammunition and Fuze Tests."
Mr. C. D. Knight.
"Projectile Development and Design."
Mr. R. H. Kent.
"Tanks."
Mr. Paul Weeks.
"Motor Carriage Artillery."
Mr. Paul Weeks.
"Tractors and Trailers."
Maj. A. S. Quinton, Ord.
"Chronographs and Star Gauging."
Mr. Jewell.
"Bombs and Bombing."
Capt. A. H. Luse, Ord.

Opportunity to Fly

One of the most interesting experiences for some of the reserve officers was the opportunity given for a flight in one of the many types of airplanes stationed at the aviation field at the Proving Ground. Many had not flown before and thoroughly enjoyed the thrill of it. The opportunity was given in connection with the demonstration of loading bombs on airplanes and dropping them. The recent safety regulation was followed and each passenger was equipped with a parachute neatly done up in a package attached to himself, either fore or aft, provided with a little black ring to which he desperately clung, making ready to pull in the emergency of a hasty alighting from the airplane in the upper regions.

Social Side Not Neglected

The social side was not entirely neglected and pleasant opportunities were given for the reserve officers to meet the officers of the post and their families. One of the most interesting was a reception given by the Officers' Club on the lawn of the Commanding Officer's residence to all of the reserve officers and the officers and ladies of the post. Col. and Mrs. Tschappat were delightful hosts. In return the reserve officers provided an evening of moving pictures and dancing for the entertainment of the officers and ladies of the post. Many of the officers stationed at the Proving Ground entertained the visiting officers in their homes and at the Club. These social gatherings were the means of renewing war time acquaintanceships and of causing the personal touch that is so essential in solving the problems of welding into one army the regular and reserve forces.

Time for Play, Too

After four o'clock on nearly every day for those who still felt sufficiently strenuous there were opportunities for swimming, golfing, baseball and pistol practice. At Plum Point a swimming float was located in water amply deep enough for diving, and many were the pleasant parties that gathered there for a cool plunge. For golfing there was a nine-hole course that wandered over the parade grounds, roads, and lawns, and skirted the bay shore, providing enough hazards to make the play interesting. Others were inclined toward baseball and there were preliminary practices for a match between the lieutenants and captains of the reserve officers, which the captains won. Pistol practice was a part of the regular instruction, but a competitive zest was supplied by the offer of a silver cup, by Maj. Joseph H. Steinmetz, O. R. C., to the officer making the highest score. This led to many of the officers practicing on the range in their recreation hours. The cup was won by First Lieut. Earl Naramore, O. R. C.

As previously stated the purpose of this training camp was to provide for the reserve officers a very general survey of the scope of the Ordnance Department. It was announced that the camp next year would probably be more specific in its aim and that an effort would be made to give particular instruction for the officers in those special phases of the ordnance work in which they have their reserve assignments. It was the consensus of opinion of those in attendance that the camp had proved a very successful one in meeting its purposes and that great credit was due to those who planned its work and supervised its accomplishment.

Roster of Officers:

Following is a roster of the reserve officers who were in attendance:

Colonels—
Storm, Christian G.
Wagner, Frederick H.

Lieutenant Colonels—
Bull, Frederick C.
Hubbard, Archibald B.
Ransom, William H.
Skinner, James D.
Stephenson, Frank J.
Weil, Isaac.

Majors—
Blatchly, Charles K.
Brothers, George R.
Campbell, Jeremiah.
Carlin, Andrew F.
Carlson, Raymond E.
Curtin, John.
Eaton, Bernard L.
Ellis, Charles B.
Erwin, Henry.
Ewell, Arthur W.
Gaillard, David St. P.
Green, Samuel G.
Mailler, James W.
McQuigg, Charles E.
McRae, Colin E.
Moore, Thomas.
Runk, Louis B.
Steinmetz, Joseph A.
Thorn, Stephen S.
Walker, Lee E.

Captains—
Avery, Nathan C.
Barnes, Maxwell F.
Bell, Joseph P.
Benedict, Byron W.
Black, Charles C.
Clark, Milford H., Jr.
Connelly, William F.
Cook, Robert G.
Cooke, Frederick C.
Cooley, Harry E.
Helfert, John A.
Hall, Herbert H.
Karnes, James C.
Locke, Franklin C.
Mahony, William P.
Marsh, Henry N.
McMillan, Archibald.
McNiven, Frank R.
Mellen, Charles B.
Murray, Joseph D.
Olmstead, Henry H.
Pagter, Amos T.
Resni-Coff, Murray H.
Roberts, Henry G.
Schmidt, Lindley G.
Strawn, Floyd L.
Sveshnikoff, Vladimir V.
Van Brunt, Edmond S.
Webster, Granville E.
Woolson, Clifford G.

1st Lieuts.—
Allison, William L.
Brace, Charles A.
Cetrule, John.
Ensminger, LeRoy C.
Feinberg, Benjamin G.
Floreyk, Edward M.
Hoon, Joseph B.
Ivery, Claude W.
James, Thomas E.
McNair, George H. S.
Montgomery, Walter H.
Naramore, Earl.
Oliphant, Abner C.
Rehldender, Douglas L.
Smith, Samuel A.

2nd Lieuts.—
Becher, Charles F.
Black, Roland N.
Channon, Hiram S.
Davidson, John L.
Engelman, Vernon G.
Ettleman, Walter I.
Gafvert, Gustaf A.
Guida, Michael P.
Grant, Taylor B.
Parker, Alban J.
Poole, Edward S.
Reed, Daniel H.
Rickles, Nathaniel H.
Smith, Charles S.
Stevens, Clarence C.
Taylor, John S.
Tremaine, Lyman L.

The Rock Island Camp

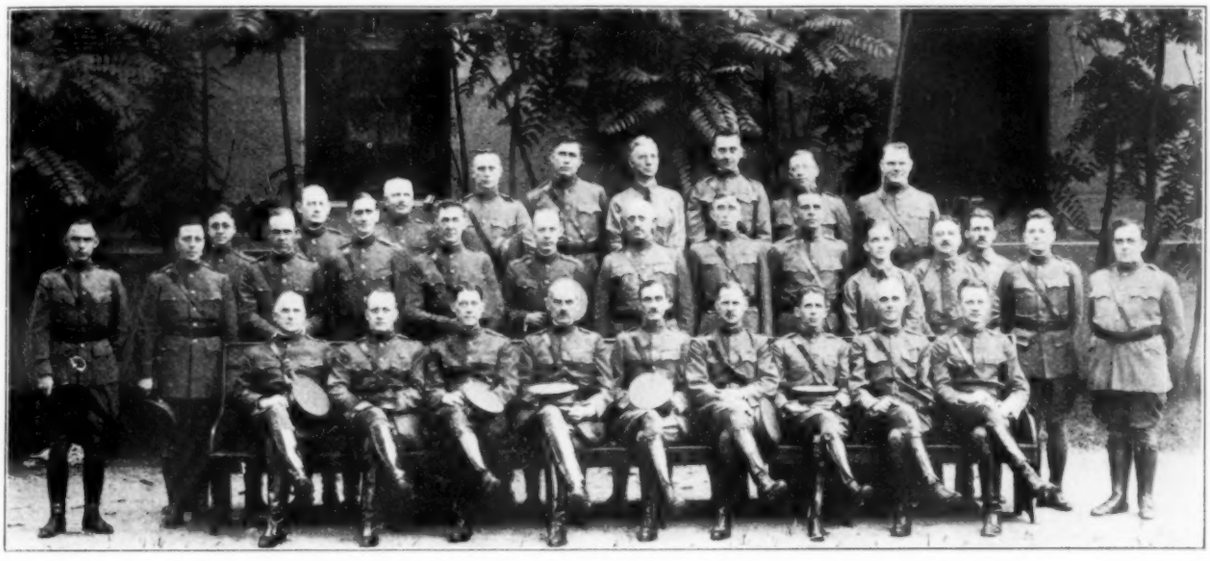
By

Capt. George W. Outland, Ord. U. S. A.

WHY a reserve officer? What good does his commission do him in private life? Of what value is he to his Government? Had all Ordnance Reserve Officers attended the Training Camp at Rock Island Arsenal between August 3rd and August 17th, they could give clear and definite answers to these questions.

Seventy officers were anticipated, forty were prepared for and twenty-six arrived.

The time was ideal and the weather pleasant; the course was interesting and instructive. Little intensive study was required and plenty of time remained for recreation.



Ordnance Reserve Officers in Attendance at Training Camp, Rock Island Arsenal, August, 1924

Cots with all the necessary bedding were furnished in stone barracks. Ample toilet and bathing facilities including showers were provided. The mess hall was in the same building and an abundance of good substantial food was served at every meal.

The opening program each day was one-half hour of drill and calisthenics. This afforded an opportunity for all to brush up on their military instructions as well as to revive many apparently long dormant muscles. The physical condition of the entire class showed marked improvement after the two weeks' training.

The course in Ordnance training was general in nature. This being the first Ordnance Camp attended by the great majority of the class since the war, afforded an opportunity for all to grasp the immensity of the Ordnance problem. Few had ever before had the opportunity or time to seriously consider the many functions of the Ordnance Department in its relation to the other branches of the service.

Two weeks is entirely too short a time to cover a course of this nature with any degree of thoroughness. Many important features must necessarily be omitted. It affords, however, a substantial basis upon which special courses may be built in the future. All Reserve Officers should attend at least one course of this type, in order to acquaint themselves with the Ordnance problem as a whole, before undertaking courses along special lines in which work he would be employed in time of war.

The course comprised work in the Manufacturing Department, Inspection Department and Field Service. Opportunity was provided for seeing all the facilities in these departments at the Arsenal. The manufacturing work included the equipment, small arms, artillery and automotive departments. The inspection work covered the inspection during manufacture, the proof work on completed vehicles and the inspection before issue to the using services. The field service covered the methods of supply to troops and the maintenance of vehicles, guns, equipment, etc., in storage. In addition to this the internal business and administrative duties in connection with the Arsenal were briefly explained, the equipment of a Heavy Maintenance Company and its relation to troops both during peace and war was outlined, and a summary of the development work in connection with Ordnance matériel was divulged.

Motion pictures, lantern slides, charts, photographs and where possible, vehicles and equipment were used to present the various subjects to the class. Opportunity was afforded at all times to ask questions in regard to any features covered in the course that were not entirely made clear by the instructors. Two of the Reserve Officers had been stationed at this Arsenal for a considerable number of years in a civilian capacity and proved quite valuable in assisting with the instruction in certain departments.

Instruction in the use of the .45-cal. pistol was also given and a range in one of the buildings was used for target practice. Many of the officers had never before had the opportunity to obtain this instruction and a marked improvement in their shooting ability was shown. Although this part of the course was optional and held after working hours, practically all the class were present for the instruction and were enthusiastic in the work.

Out of class hours the officers had free use of the 18-hole golf course and the tennis courts on the island. The courtesies of various clubs and Y. M. C. A.'s in the Tri-Cities near the island were extended them. A dinner was held in their honor at the Golf Club with all the Ordnance Officers at the Arsenal in attendance. Speeches and songs and a very interesting illustrated talk by Col. King were enjoyed by all.

The entire class expressed deep appreciation in being able to attend this camp and regretted that more Reserve Officers were unable to be present. In going back to their civilian occupations they carry away a finer conception of the Ordnance Department, its problems and its complexities.

The Ordnance Department has unquestionably gained a lasting benefit by obtaining the services of such men, high in their various occupations, for this short period of training.

The lectures included:

"The Ordnance Problem."
Major G. H. Stewart.
"Mass Procurement."
Capt. H. A. Nisley.
"Organization of a Manufacturing Arsenal."
Maj. H. Hoisington.
"Fundamentals of Ordnance Design."
Maj. L. H. Campbell.
"War Time Procurement and Issue of Munitions."
Capt. Nisley.
"Industrial War Plans of the Ordnance Department."
Capt. R. P. Mortimer.
"Ordnance Specifications."
Capt. Nisley.
"Receipt, Storage and Issue of Raw Materials."
Mr. V. H. Veithe.
"Tests of Metals and Materials."
Mr. P. C. Cunnick.
"Inspection of Materials."
Mr. A. C. Forrest.
"Ordnance Drawings and Drawing System."
Mr. G. F. Summers.
"Floor Inspection of Artillery Material."
Mr. A. C. Forrest.
"Design and Manufacture of Recuperators."
Maj. H. B. LaRue.
"Inspection and Proof of Small Arms."
Mr. H. J. Risley.
"Inspection and Proof of Artillery Matériel."
Major Hoisington.
"Gages and Fine Tools."
Mr. H. H. Grace.
"Progress Reports and Shop Planning Methods."
Mr. E. A. Grassley.
"Post War Development in Small Arms and Machine Guns."
Major Stewart.
"Finance: Payroll, Account Current and Disbursements."
Mr. L. H. Carstens.
"Cost Accounting and Civil Service Regulations."
Mr. C. M. Dollarhide.
"Supply of Ordnance Matériel."
Capt. E. C. Goebert.
"Post War Development in Artillery, Tanks and Tractors."
Major Campbell.
"The Ordnance Provision System."
Capt. Goebert.
"Duties of the Ordnance Maintenance Company."
Major Hoistington.
"Storage, Shipments and Property Accounting."
Capt. Goebert.

Those who attended the course were:

Lieut. Cols. Henry O. Bernhardt and Claude E. Fitch.

Majors Milo W. Case, Leon W. Chase, Harry Hoistington, Hugh B. LaRue, James T. Moody, Virgil A. Root, Jay A. Utts and Otis K. Wright.

Captains Percy C. Avery, Raymond B. Harris, Harold G. Stevens, Walter M. Wickham and Lester T. Wilson.

1st Lieuts. Floyd M. Bevins, Arthur E. Brooks, Mark M. Conklin, Clifton R. Hovland, Edgar R. Lower, Martin N. B. Minne, Rufus R. Rosell, Harold G. Evans, Temple O. Merchant and Edgar C. Schroyer.

Major William H. Gelshenen

WE regret to record the death of Major William H. Gelshenen, a charter member of the Army Ordnance Association and one of the foremost figures of the chemical industry in this country, who died after a short illness in New York City, July 22, 1924.

Major Gelshenen served in the Ordnance Department during the World War as chief of the Chemicals Section of the Procurement Division and as a member of the staff of the Chief of that Division, Col. R. P. Lamont. Shortly after the outbreak of the war he assumed direction of the chemical activities of the Ordnance Department at that crucial period when the task demanded an experienced administrator who could organize and coordinate the production and purchase of chemicals to meet the tremendous explosives requirements of the Department. As chief of the Chemicals Section and as a member of several committees of the War Industries Board as well as chairman of many of the War Department Commodity Committees on chemicals and chemical products, the work of Major Gelshenen will be remembered by his associates as one of the great accomplishments of the Department during those trying days.

Forty-three years of age at the time of his death, Maj. Gelshenen was yet at the threshold of a brilliant career. He was a graduate of the Sheffield Scientific School of Yale University, Class of 1903. He served for a time as first vice-president of the Garfield National Bank of New York City, of which his father had served as president for many years. At the time of his death, Major Gelshenen was a member of the Board of Directors of that Bank. Since 1908 he had been a member of the firm of H. J. Baker & Brother, importers and exporters of heavy chemicals and fertilizer materials.

In his untimely death the chemical industry loses one of its leading figures and the Army Ordnance Association an esteemed and able member.

The Chicago Ordnance District Advisory Board

MR. E. A. RUSSELL, Chief of the Chicago Ordnance District, has recently announced the appointment of an Advisory Board to assist in the formation of industrial preparedness plans in the Chicago Ordnance District. The Board comprises some of the foremost industrial and civic leaders of the Middle West who are well fitted to undertake this important work. The members of the Board are: Mr. Frank R. Bacon, Mr. William Butterworth, Mr. William Wheeler Coleman, Gen. Charles Gates Dawes, Mr. Albert Russell Erskine, Mr. G. M. Gillette, Col. Robert P. Lamont, Mr. Alexander Legge, and Mr. John J. Mitchell. We publish herewith a short biographical sketch of each of the members whose photographs are shown on the following pages.

WILLIAM BUTTERWORTH

Mr. Butterworth, a prominent industralist of Moline, Illinois, was born at Mainville, Ohio, December 18, 1864, the son of Benjamin and Mary Ellen Seiler Butterworth. He was educated in the public schools of Cincinnati, Ohio, and Washington, D. C., and at Lehigh University. In 1892 he married Katherine Mary Deere of Moline, Illinois.

Mr. Butterworth was in the employ of the United States Government at the Paris Exposition in 1889 and served as private secretary to the United States Commissioner of Patents, 1891-1892. He was admitted to the Illinois Bar in 1892 and shortly thereafter located in Moline, Illinois. Beginning as assistant buyer for Deere and Company in 1892, he successively became buyer, treasurer in charge of operations, and finally in 1907, upon the death of Charles H. Deere, he became president of the Company and an officer and director of its subsidiary enterprises.

Mr. Butterworth is president of the Peoples Saving Bank and Trust Company; a director of the United Light and Railways Company; honorary vice-president of the United States Chamber of Commerce, a member of the Executive Committee of the National Industrial Conference Board, also of the Advisory Committee of the Illinois Manufacturers Association and of the National Association of Farm Equipment Manufacturers. He is also a member of the American Historical Association, the Illinois Historical Association, Sons of the American Revolution, the Royal Society of Arts (England) and Psi Upsilon.

Mr. Butterworth is a member of the following clubs: Moline (Illinois), Metropolitan (Washington), Congressional Country Club (Washington), Chicago University, Saddle and Cycle, and Union League (Chicago). His home is in Moline, Illinois.

WILLIAM WHEELER COLEMAN

Mr. Coleman, manufacturer and engineer, was born in Baltimore, Maryland, November 21, 1873. He received the degree of Bachelor of Science in Metallurgy from Lehigh University in 1895 and shortly thereafter entered the employ of the Bethlehem Steel Company acting as metallurgical engineer and as open hearth and mill superintendent until 1902. He also was connected with the Crucible Steel Company of America and the Latrobe Steel and Coupler Company. In 1905 he became associated with the Bucyrus Company of which he became president in 1905.

Mr. Coleman's exceptional experience in the manufacture of Ordnance enabled his Company to become one of the foremost producers of armament during the World War. In 1915-1916, the Bucyrus Company manufactured 8-inch shells for the British Government. Upon the entrance of America into the conflict the company turned to the production of 75-mm. recuperator forgings and other ordnance material. In May, 1917, he formed the Wisconsin Gun Company which produced 3-inch and 75-mm. guns for the Ordnance Department.

Colonel Coleman entered the Ordnance Department in April, 1918, and in September of that year was appointed an assistant to the Chief of Ordnance in charge of artillery production. After the termination of hostilities he returned to civilian life. He has served as Vice-President of the Army Ordnance Association since its foundation.

GEN. CHARLES GATES DAWES

General Dawes, nominee for the Vice-Presidency, was born in Marietta, Ohio, August 27, 1865, the son of General Rufus R. and Mary Beman Gates Dawes. He received his A.B. degree at Marietta College in 1884, M. A. in 1887, and LL.B. Cincinnati Law School, 1886. He married Miss Caro D. Blymer of Cincinnati, January 24, 1889.

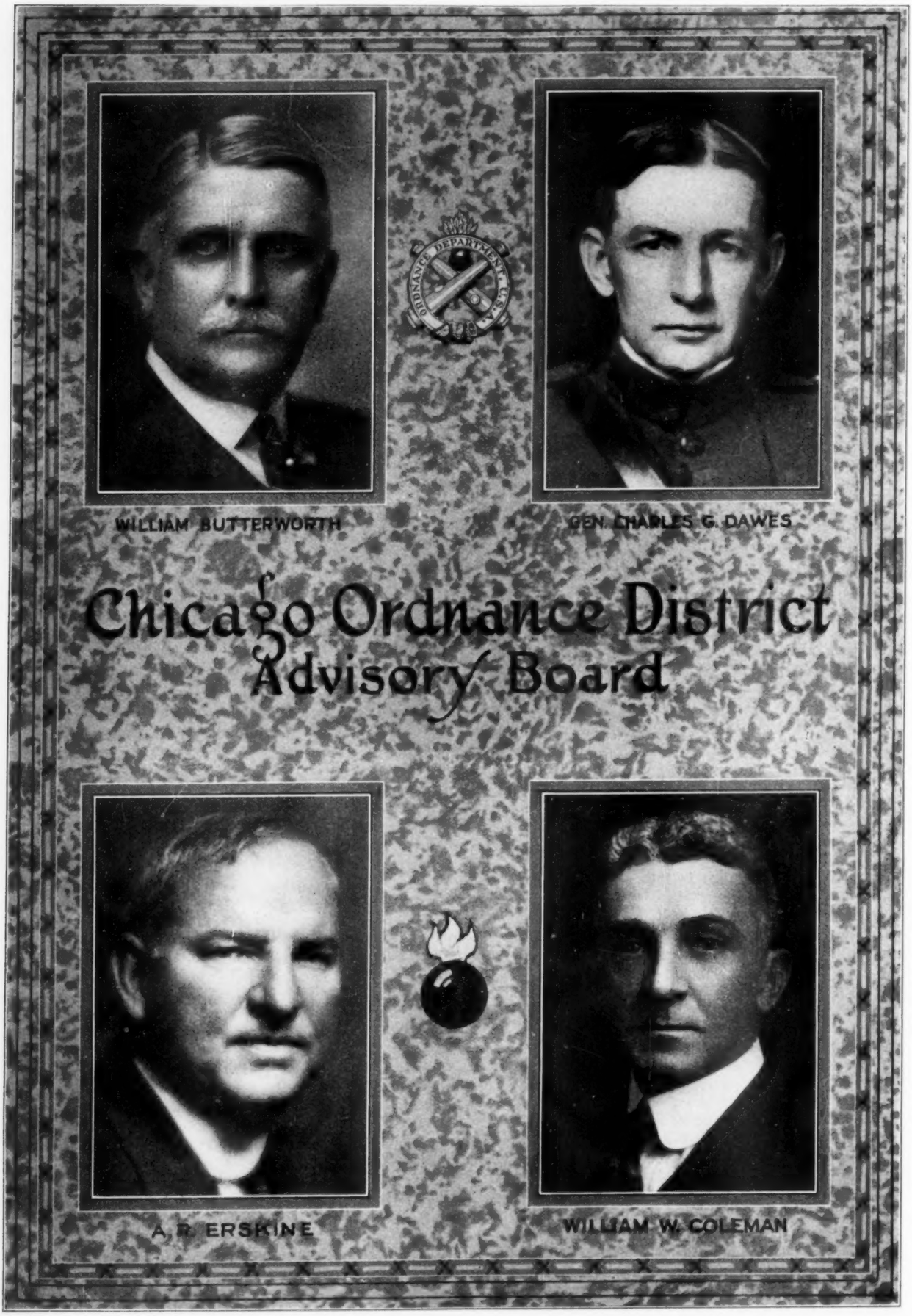
General Dawes was admitted to the Bar in 1886 and practiced at Lincoln, Nebraska, until 1891.

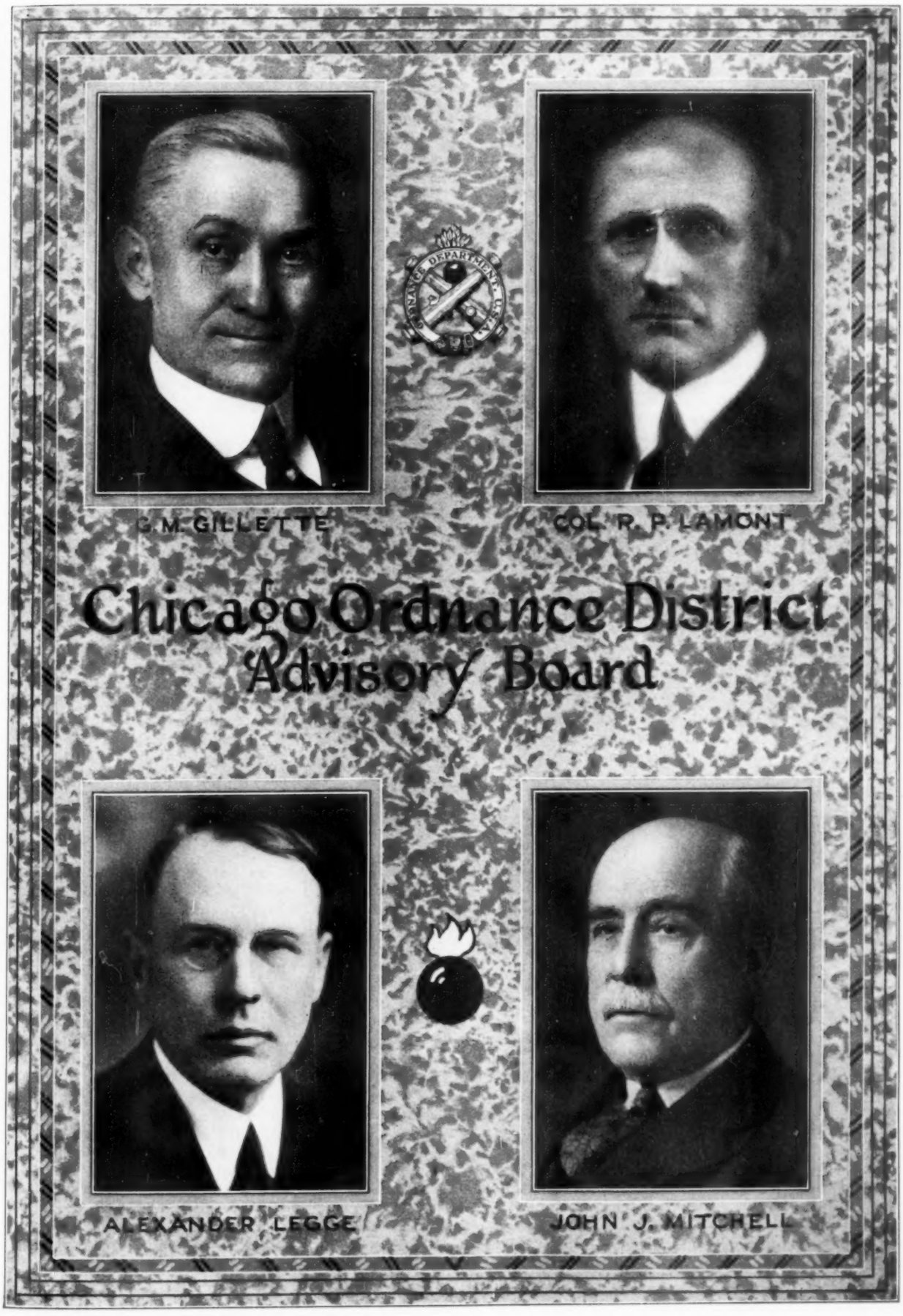
His public career began in 1896 when he served as executive to President McKinley in Illinois and as a member of the Republican National Committee. He served as Controller of the Currency from 1898 to 1902. In 1921 he assumed the Directorship of and installed the Federal Budget System. He was also a member of the Allied Reparations Committee to Investigate German Finances. He is chairman of the Central Trust Company of Illinois and President of the Rufus F. Dawes Hotel Association.

General Dawes' military activities began with his commission as a major, U. S. National Army, in June, 1917. He was promoted to Lieutenant Colonel in July of the same year, Colonel, January, 1918, and Brigadier General, October, 1918. In September, 1917, he was appointed to the administrative staff of the Commander-in-Chief, American Expeditionary Forces, and acted as chairman of the General Purchasing Board and General Purchasing Agent of the A. E. F. Later, he was a member of the Allied Purchasing Board and of the Allies' Liquidation Commission. He resigned from the Army and returned to the United States in August, 1919.

General Dawes has received the following decorations: Distinguished Service Medal (United States), Order of Leopold (Belgium), Commander of the Legion of Honor and the Croix de Guerre, with palm (France), Order of Saints Maurice and Lazarus (Italy).

He is the author of the following books: "Essays and Speeches," "The Banking System of the United States," "A Journal of the Great War," and "The First Year


WILLIAM BUTTERWORTH
GEN. CHARLES G. DAWES
Chicago Ordnance District
Advisory Board
A. R. ERSKINE
WILLIAM W. COLEMAN


G. M. GILLETTE
COL. R. P. LAMONT
Chicago Ordnance District
Advisory Board
ALEXANDER LEGGE
JOHN J. MITCHELL

of the Budget of the United States." General Dawes is a member of the Chicago, Union League, University, Onwentsia, Glen View, Evanston, Evanston Country and Evanston Golf Clubs. His home is in Evanston, Illinois.

ALBERT RUSSELL ERSKINE

Mr. Erskine, President of the Studebaker Corporation, was born in Huntsville, Alabama, January 24, 1871. He is descended from a line of pioneer American Anglo-Saxon ancestors; his grandfather, Dr. Alexander Erskine and his great grandfather Dr. Albert Russell, a colonel in the Revolutionary War, having been among the earliest settlers in Huntsville. In 1903 he married Miss Anne Lyell Garland, of Huntington, W. Va.

Mr. Erskine attended public and private schools and at the age of 15 entered the employ of a railroad as office boy. At the age of 27 he became chief clerk at the Saint Louis office of the American Cotton Company.

From 1904 to 1910 he was treasurer and a member of the Board of Directors of the Yale and Towne Manufacturing Company. He became treasurer and member of the executive committee of the Studebaker Corporation in 1911 and was made first vice-president in 1913 and president in 1915, which latter position he fills at the present time.

In December, 1918, Mr. Erskine was elected to membership on the Board of Directors of the Federal Reserve Bank of Chicago and served three years.

His clubs include: Indiana, Rotary, South Bend Country, Detroit Athletic, and the Bankers and St. Andrews Golf of New York.

G. M. GILLETTE

Mr. Gillette, of Minneapolis, Minn., was formerly president of the Minneapolis Steel and Machinery Company. For 15 years he acted as president of the Minnesota Employers' Association. He also served as a director of the Twin City Forge and Foundry Company, which produced large quantities of 155-mm. shell forgings and machined shell during the World War. He was one of the first employers in the United States to advocate workmens' compensation laws.

The Minneapolis Steel and Machinery Company during the War devoted almost its entire capacity to the production of war material. It furnished the Ordnance Department all the 155-mm. gun carriages built in this country, in addition to large quantities of 155-mm. shell and over 6,000 cargo winches and other structural material for the United States Shipping Board.

Mr. Gillette was active during the period of the World War in correlating the manufacturing forces of the Northwest.

COL. R. P. LAMONT

Colonel Lamont, President of the American Steel Foundries, was born in Detroit, Michigan, December 1, 1867, the son of Robert and Isabelle Patterson Lamont. He received the degrees of Bachelor of Science in Civil Engineering from the University of Michigan in 1891 and Master of Arts in 1912. In 1894 he married Miss Helen Gertude Trotter of Chicago.

Colonel Lamont has been engaged in the following activities: Engineer at the Chicago Exposition, 1891-92; secretary and engineer, Shailer and Schinglau Company, 1892-97; first vice-president, Simplex Railway Appliance Company, 1897-1905; first vice-president American Steel Foundries, 1905-1912 and president of the company since 1912. He is also chairman of the Board of the Griffin Wheel Company, Director of the First National Bank of Chicago and of the Morris Plan Bank, Montgomery Ward and Company, Armour and Company, International Harvester Company, Globe Steel Tubes Company. He is a trustee of the Art Institute of Chicago and of the University of Chicago.

Colonel Lamont was commissioned a major in the Ordnance Department in February, 1918. In October of that year, with the rank of Colonel, he was appointed Chief of the Procurement Division, Office of the Chief of Ordnance. He returned to civil life in February, 1919.

Colonel Lamont is a member of the Chicago, Union League, University, Mid-day, Shore Acres, Old Elm and Glenview clubs. His home is at Lake Forest, Illinois.

ALEXANDER LEGGE

Mr. Legge, president and director of the International Harvester Company, was born in Dane County, Wisconsin, January 13, 1866, the son of Alexander and Christina Fraser Legge. He was educated in the public schools of Wisconsin and Nebraska.

In 1891 he entered the employ of the McCormick Harvesting Machine Company as collector and saleman in the Omaha agency. He successively held the positions of collection agent at Council Bluffs, 1894, general agent at Council Bluffs in 1897, and manager of the collection department at Chicago, 1899.

In 1903 he was made assistant manager of domestic sales for the International Harvester Company of America, assistant general manager in 1906, and general manager in 1913. He became vice-president and general manager of the company in 1919 and president in 1922.

During the World War, Mr. Legge served on the Allied Purchasing Commission and as vice-chairman of the War Industries Board. He also served as commercial adviser at the Versailles Peace Conference.

He is a member of the Chicago, Commercial, Chicago Athletic, Illinois Athletic, and Press Clubs of Chicago, and the Metropolitan Club of Washington, D. C. His home is at Hinsdale, Illinois.

JOHN J. MITCHELL

Mr. Mitchell, financier, was born in Alton, Illinois, November 3, 1853, and was educated in the public schools there and at Kent Hill, Maine. He entered the employ of the Illinois Trust and Savings Bank in 1873 and became president in 1880. In 1890 he married Miss Mary Louise Jewett, of Bristol, R. I.

Mr. Mitchell, in addition to being a member of the Advisory Board of the Chicago Ordnance District, is a trustee and member of the advisory committee of the American Surety Company and is a director in the following organizations: Chicago and Alton R. R., Pittsburgh, Fort Wayne and Chicago R. R., Kansas City Southern R. R., the Pullman Company, Chase National Bank of New York, Illinois Trust and Safe Deposit Company, International Harvester Company, Illinois Bell Telephone Company, Commonwealth Edison Company, Art Institute of Chicago, and trustee of the Mutual Life Insurance Company of New York.

During the World War Mr. Mitchell served on the Chicago District Claims Board.

He is a member of the Chicago Union League, University, and Mid-day Clubs of Chicago, and Lake Geneva Country Club, the Bankers' Club of New York and the Midwick Club of Pasadena. His home is at 1550 N. State Street at Parkway, Chicago.

Electroplating Worn Machine Gun Barrels*

By

W. W. DE SVESHNIKOFF and H. E. HARING

AT various times the possibility of relining gun barrels by electrodeposition has been suggested. If such a process could be accomplished it might prove applicable in experiments upon the factors causing erosion of barrels, and also in the salvaging of used barrels. Worn steel parts have been rebuilt by electrodeposition,[1] but the plating of interior surfaces involves inherent difficulties.

A machine gun barrel is regarded as worn out when the projectile ceases to rotate properly because of destruction of the rifling. However, at this point the bore is only slightly enlarged and the bore wall is not cracked to a sufficient extent to weaken it. The deteriorating effect of high temperature is noticeable for only a slight depth into the wall of the barrel. Below this highly heated thin surface layer the steel has been subjected to a moderate temperature only. By microscopic examination it has been observed that the structure of the steel of the barrel is unchanged with the exception of a very thin surface layer of a few ten-thousandths of an inch.

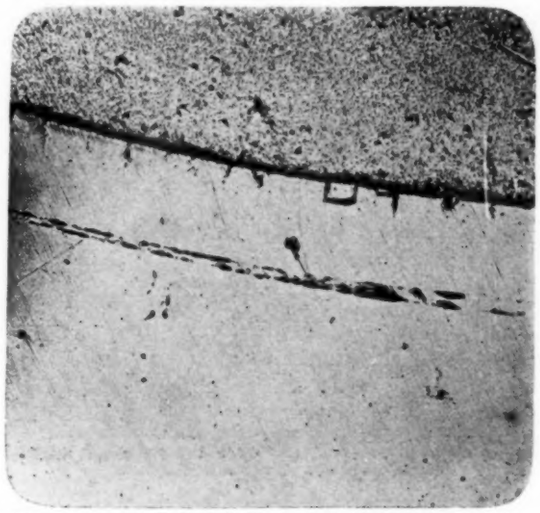


Fig. 1. Nickel deposited from fluoride solution. X 100. Current density 3.5 amp.-sq. ft. Unetched. Thickness .006 in.

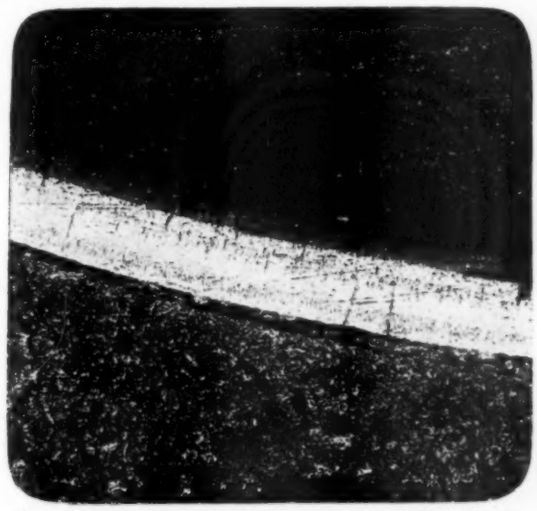


Fig. 2. Nickel deposited from fluoride solution. X 100. Current density 3.5 amp.-sq. ft. Etched in a mixture of 50 per cent nitric and 25 per cent acetic acid in water.

The idea of plating the bore surface has been previously suggested, and in 1907 at the Naval Proving Ground a series of tests were conducted on nickel-coated plugs to study the reduction of erosion. Experiments have also been made abroad in which the fundamental idea was that if a metal of very high melting point were plated on the bore wall the lower fusibility of the plating would combat erosion, the assumption being that erosion is largely due to high temperature. In these latter experiments on large guns the bore received a very thin coating on top of the rifling. This reduced the diameter of the bore so that the behavior of such a gun would not be exactly comparable to that of one of normal diameter. Measurements with the star gauge showed that the plating was almost completely removed by the first shots.

In 1921 a few experiments were conducted by the authors to determine whether a plating process could be used to reline machine gun barrels. The results as described in this paper indicate that with the information and methods then available the process was not practicable. It is at least possible, however, that now or at some future time means may be found for overcoming or counteracting the difficulties then encountered. These results are therefore published chiefly for record, and as a guide to those who may consider further study of this problem.

Experimental Methods

In order to insure an adequate thickness of the de-

*Published by permission of the Director of the Bureau of Standards and of the Chief of the Ordnance Department, U. S. Army.

[1] W. A. MacFayden, An Aspect of Electrolytic Iron Deposition, Trans. Far. Soc. 15, 98, (1920).
W. E. Hughes, Building up Worn Metal Parts by Electrodeposition, Chem. & Met. Eng., 26, 267, (1922).
Bradley Stoughton, Electrolytic Iron a Commercial Product, Chem. & Met. Eng., 26, 128 (1922).
J. D. Alley, Saving Worn Parts by Electrodeposition, Brass World, 19, 373 (1923).
N. B. Pilling, Effect of Heat Treatment on the Hardness and Microstructure of Electrolytically Deposited Iron, Trans. Am. Electrochem. Soc., 42, 9 (1922).
H. D. Hineline, Notes on the Electrodeposition of Iron, Trans. Am. Electrochem. Soc., 43, 119 (1923).
B. H. Thomas, Electrodeposition in Automotive Repair Work, Automotive Ind. 43, 418 (1920).

posited metal to withstand the probable service, the barrels were reamed out at the Springfield Arsenal, to increase the diameter of the bore by 0.04-inch. This left sufficient space to produce within the bore metal deposits which could be machined down to 0.02-inch in thickness, and in which the rifling could then be cut.

In order to prevent oxidation in transit the barrels

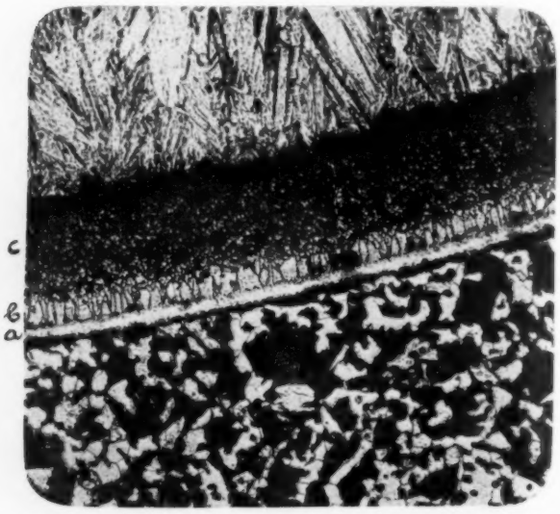


Fig. 3. Nickel deposited from fluoride solution. X 100. Current density 3.5 amp.-sq. ft. After annealing 30 minutes at 1000° C. Same etching as in Fig. 2. a, compact layer; b, crystaline layer; c, spongy layer

were coated with oil after reaming. The interior of the barrels was cleaned with organic solvents to remove grease, and just before the plating operation an electrolytic cleaning process with an alkaline solution was applied. Owing to the presence of pits and flaws in the bore surface, difficulty was experienced in securing an absolutely clean surface.

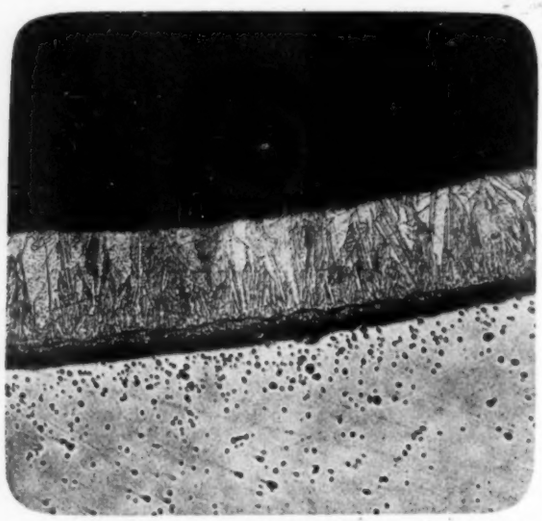


Fig. 4. Copper coating. X 60. Etched in ammonia and hydrogen peroxide. Thickness .009-inch

Of those metals which are electrolytically precipitable, nickel, cobalt[2], iron and chromium[3] have the highest melting point, hardness and tensile strength, and might therefore be expected to be most serviceable for gun linings. A few experiments with nickel were made upon gun barrels and with iron and copper upon short sections. The other metals mentioned should be considered in any future work.

Owing to the small diameter of the bore it is necessary to have, as the anode, a very carefully centered wire or rod. It was found impracticable to employ a nickel rod, owing to short circuiting, and hence a tightly stretched platinum wire was used as the anode. With an insoluble anode the nickel solution has a tendency to become acid. To counteract this tendency the solution was run rapidly through the rifle barrel, which was mounted vertically, into a tank in which it was neutralized by agitation with nickel carbonate, the excess of which remained in suspension in the solution passed through the barrel.

Experiments were made with two types of nickel solutions, both containing nickel sulphate and boric acid, to one of which nickel fluoride was added and to the other nickel chloride. Previous experience had shown that nickel deposits from solutions containing fluorides are harder and have a higher tensile strength than those from corresponding solutions containing chlorides[4]. Under the conditions used, it was found that the "fluoride" deposits were brittle and entirely unsatisfactory. Those

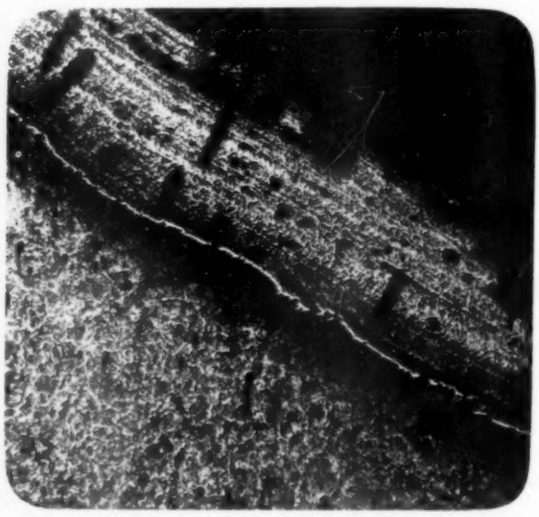


Fig. 5. Iron coating. X 100. Etched in 2 per cent nitric acid in alcohol. Thickness .009-inch

from the "chloride" solution were better, but still too brittle to be subsequently machined.

The structure of the "fluoride" nickel deposits is shown in Figs. 1, 2 and 3.

These photographs show that the deposit is not closely adherent to the steel wall of the bore. Lack of adherence may be due partly to inadequate cleaning of the surface before plating, but is at least influenced by the well known tendency of metals to contract during deposition[5] and thus to separate from a concave surface. It is probable that the adhesion could be increased by using a slightly roughened surface, such as, for example, a sand-blasted surface. Good adherence is an absolute essential to the success of any method of re-lining.

The porosity of the coating as seen in Fig. 2 and also its brittleness may be due to the presence of hydrogen,

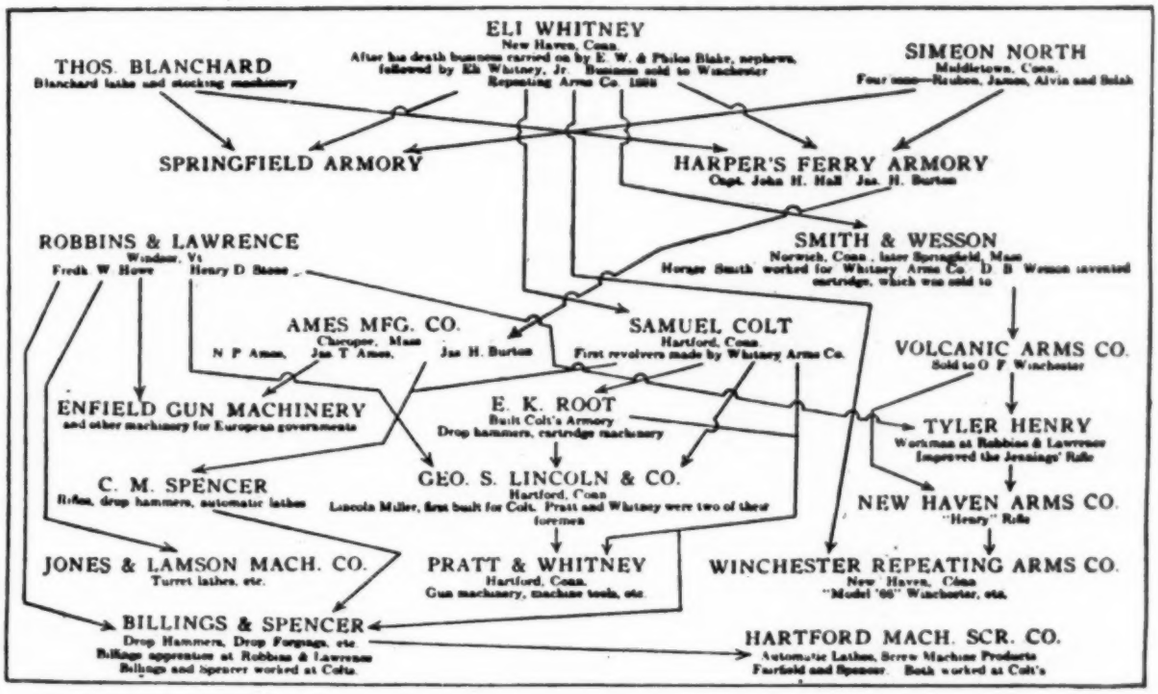
(Continued on page 544)

[2]H. T. Kalmus, C. H. Harper, and W. L. Savell, Electroplating with Cobalt, Trans. Am. Electrochem. Soc. 27, 1 (1915).
[3]K. W. Schwartz, Chromium Plating Steel Using Chromium Anodes, Trans. Am. Electrochem. Soc. 44, 451 (1923).
[4]W. Blum, The Use of Fluorides in Solutions for Nickel Deposition, Trans. Am. Electrochem. Soc. 39, 459 (1921).
[5]E. A. Vuilleumier, Application of the Contractometer to the Study of Nickel Deposition. Trans. Am. Electrochem. Soc. 42, 99 (1922).

Genealogy of the New England Gun Makers

By

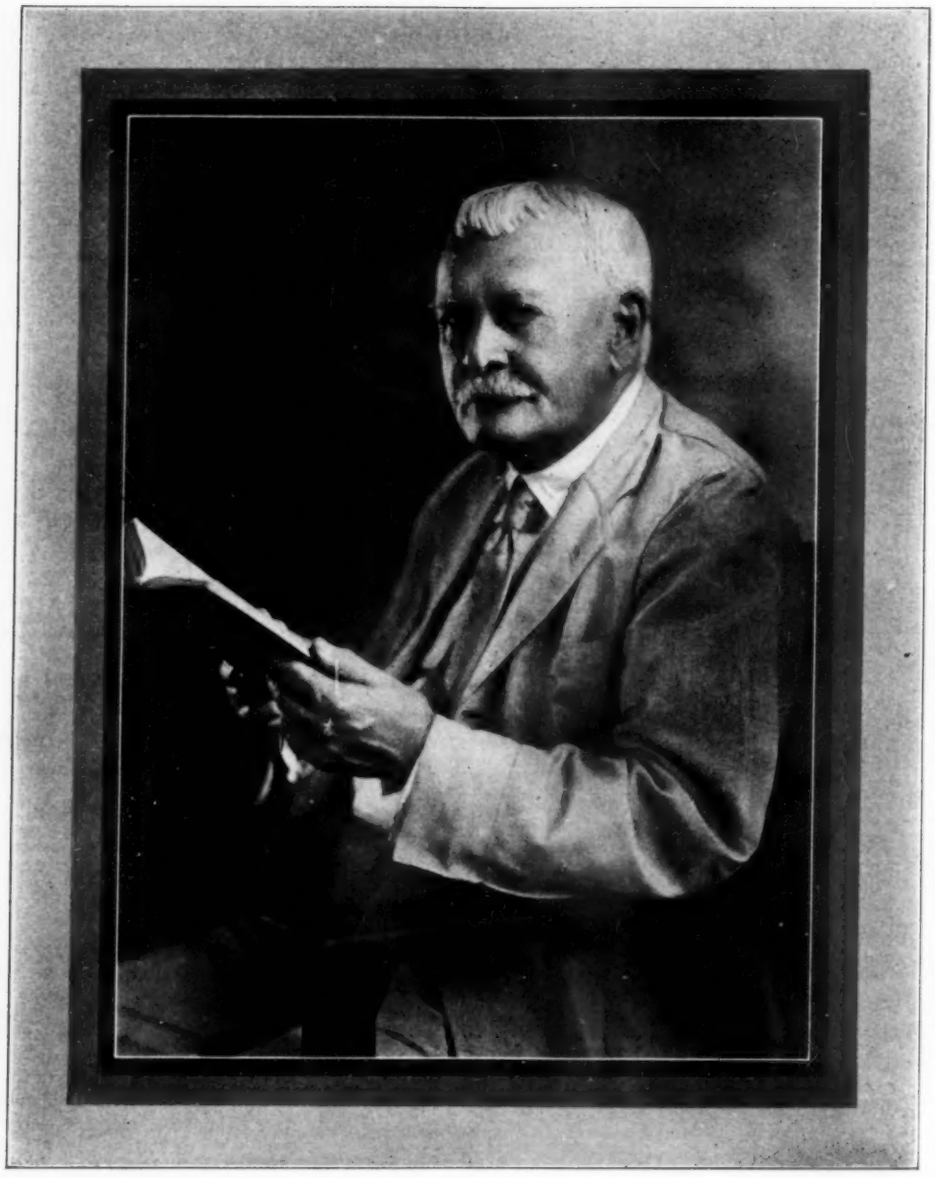
COL. JOHN Q. TILSON
Member of Congress from Connecticut


ELI WHITNEY
New Haven, Conn.
After his death business carried on by E. W. & Philos Blake, nephews, followed by Eli Whitney, Jr. Business sold to Winchester Repeating Arms Co. 1888
THOS. BLANCHARD
Blanchard lathe and stocking machinery
SIMEON NORTH
Middletown, Conn.
Four sons—Reuben, James, Alvin and Selah
SPRINGFIELD ARMORY
HARPER'S FERRY ARMORY
Capt. John H. Hall Jas. H. Burton
ROBBINS & LAWRENCE
Windsor, Vt.
Fredk W Howe Henry D Stone
SMITH & WESSON
Norwich, Conn., later Springfield, Mass
Horace Smith worked for Whitney Arms Co. D B Wesson invented cartridge, which was sold to
AMES MFG. CO.
Chicopee, Mass
N P Ames, Jas T Ames, Jas H. Burton
SAMUEL COLT
Hartford, Conn.
First revolvers made by Whitney Arms Co.
VOLCANIC ARMS CO.
Sold to O F Winchester
ENFIELD GUN MACHINERY
and other machinery for European governments
E. K. ROOT
Built Colt's Armory
Drop hammers, cartridge machinery
TYLER HENRY
Workman at Robbins & Lawrence
Improved the Jennings' Rifle
C. M. SPENCER
Rifles, drop hammers, automatic lathes
GEO. S. LINCOLN & CO.
Hartford, Conn.
Lincoln Miller, first built for Colt. Pratt and Whitney were two of their foremen
NEW HAVEN ARMS CO.
"Henry" Rifle
JONES & LAMSON MACH. CO.
Turret lathes, etc.
PRATT & WHITNEY
Hartford, Conn.
Gun machinery, machine tools, etc.
WINCHESTER REPEATING ARMS CO.
New Haven, Conn
"Model '66" Winchester, etc.
BILLINGS & SPENCER
Drop Hammers, Drop Forgings, etc
Billings apprentice at Robbins & Lawrence
Billings and Spencer worked at Colts
HARTFORD MACH. SCR. CO.
Automatic Lathes, Screw Machine Products
Fairfield and Spencer. Both worked at Colt's

SUPPLEMENTING the article on Gages and National Defense which appeared in the May-June issue of ARMY ORDNANCE, the accompanying chart, showing the genealogy of New England gun makers may be of interest. It is taken from the very interesting and instructive book entitled "English and American Tool Makers," by Professor Joseph N. Roe.

A CAREFUL examination of the chart makes clear how the inventive genius, as well as the mechanical, engineering and executive ability, of such men as Eli Whitney, Simeon North and Thomas Blanchard have been transmitted through worthy successors,—inventors, engineers, executives and workmen,—down to the present day. Hand in hand with the development in firearms has gone the corresponding development in gunmaking machinery and the necessary devices for quality and quantity production.

THE chart shows how the present advanced state of the gunmaking art in New England is directly traceable to the three pioneers, Whitney, North and Blanchard; but this fact detracts nothing whatever from the genius and ability of the men of the intervening period, such as Samuel Colt, who invented the revolver and a number of other mechanical devices during his short and adventurous life; Christian Sharpe, who invented the breechloading rifle; Christopher M. Spencer, who invented the Spencer Repeating Rifle; Elisha K. Root, who invented the best drop hammer then in use, besides working out a very advanced system of gages, jigs, tools and fixtures; and many other inventors and engineers too numerous to mention.



HARRIS & EWING

Dr. Charles E. Munroe

Dean of American Explosives Chemists

Chief Explosives Chemist, Bureau of Mines
U. S. Department of the Interior
and
Chairman, Committee on Explosives Investigations
The National Research Council

The Purification of TNT

By

H. MURAOUR

Bulletin de la Societe Chimique de France [4], *35*, 367-379 (March, 1924)

Translated by Dr. Charles E. Munroe

Foreword

This translation is offered in publication because it deals with the purification of the most acceptable material for charging high explosive shell, and for airplane bombs, as demonstrated during the War, and the information it supplies on this matter is of primary military importance.

Moreover, it explains clearly the rationale of the purification process, thus permitting of its more intelligent application. And, finally, its publication is warranted because of its vivid portrayal of the procedure in a model experimental research, which may well serve as a guide to others.

The chemists of this country are gratified that a process originating in the United States should receive such attention and consideration from chemists of France.

CHARLES E. MUNROE.

IT IS known that commercial trinitrotoluene cannot be used in charging projectiles until it has been purified, which is usually effected by recrystallization from alcohol. During the war, when alcohol was reserved for use in the manufacture of powder, there was utilized in France a process of American origin consisting in the treatment of the trinitrotoluene, in the cold, with a dilute solution of sodium sulphite.

In December, 1915, we had an opportunity to study the mechanism of this method of purification in the Laboratoire Central des Poudres.[1] Since circumstances, over which we have no control, prevent the completion of these researches, it is believed of value to place our results on record here.

Let us inquire first into the character of the impurities to be encountered in commercial trinitrotoluene manufactured from that portion of toluene which is believed to be free from benzene and xylene.

The mononitration of toluene gives birth to a mixture consisting principally of the ortho and the para nitrotoluene, with a small proportion of the meta. The ortho and para nitrotoluenes, on further nitration, give birth exclusively to the symmetric trinitrotoluene, 2. 4. 6. The metanitro compound gives birth to two assymmetric trinitrotoluenes; the β (2.3.4) and the Υ (2.4.5) derivatives.

If then the meta nononitro derivative is not previously separated by fractional distillation, (a very hazardous process used in Germany), the crude trinitrotoluene will always contain assymmetric trinitrotoluenes.

But these are not the only impurities that may occur in crude trinitrotoluene. Without considering other assymmetric tolites (isomers of the β and Υ derivatives) which may exist as traces, unpurified commercial trinitrotoluenes practically always contain small proportions of:

(1) Tetranitromethane formed by the oxidizing action of the nitric-sulfuric acid mixture at elevated temperature. This product gives to all industrial trinitrotoluenes a pseudo-nitrous odor. It is toxic and its presence has given rise to many accidents.

(2) Trinitrobenzene. This substance, which occurs in variable proportions, but always small, is certainly produced during the washing of the crude trinitrotoluene in boiling water, following the decomposition of trinitrobenzoic acid, which has itself been formed from a part of the symmetric trinitrotoluene through the oxidizing action of the nitric-sulfuric acid mixture.[2]

(3) The reddish oxidation products react acid. Though their constitution has not been determined, they probably possess one, or several, phenolic groups. We have shown that they are likely to form very explosive lead salts. These lead salts may be easily prepared by treating crude tolite, in the cold, with a very dilute ammoniacal solution, driving out the excess of ammonia by a current of air and precipitating with a soluble lead salt.

It is such salts that cover the lead coils in alcohol crystallizing apparatus and which have given rise to numerous accidents.[3]

In addition to these products we observe in crude trinitrotoluene:

(a) Dinitro derivatives of toluene if the nitration has not been complete.

---

[1]Our notes bear date of Dec. 13, 1915; Jan. 11, 1916; Feb. 18, 1916; Feb. 25, 1916; April 22, 1917; Aug. 7, 1917, and Jan. 19, 1918. The study of the action of sodium sulfite on trinitrotoluene was also made by Mr. Butterlin, at the Poudreric de Saint-Fons, who arrived at the same conclusions as I did, and particularly as to the elimination of the assymmetric trinitrotoluenes.

[2]One might expect crude trinitrotoluene to also contain traces of assymmetric trinitrobenzenes formed by the oxidation of methyl groups of assymmetric trinitrotoluene and the eventual separation of the carboxyl group, but we have been able to prove that the two trinitrobenzoic acids which correspond to the β and γ-trinitrotoluenes do not lose the carboxyl group by boiling water. The presence of two nitro groups in the ortho position is essential for this eliminatin to be effected.

[3]These salts cannot be formed until the trinitrotoluene has been freed from all mineral acid by washing. These oxidation products, however, can displace the nitric group from lead nitrate when heated. The products of the acid function existing in crude tolite should be the subject of careful study. Our preliminary trials have shown that the nitrous trinitrotoluene contains at least two acid bodies, one (perhaps a dinitro-cresol) which is easily soluble in water in the presence of $CaCO_3$, or in ammoniacal water, and which forms a yellow lead salt quite easily soluble in water; the other (perhaps consisting of one, or more, derivatives of diphenyl or stilbene) is much less soluble in water, even in the presence of $CaCO_3$, or of ammonia. It forms a lead salt varying from brown to reddish-brown, and but slightly soluble in water. After washing the trinitrotoluenes will contain a notable amount of the second compound only, the first undoubtedly having, because of its great solutility in water, been eliminated. The lead salts of both of these compounds are explosive, but the brown salt deflagrates with greater violence, superior even to that of lead picrate, which it resembles. The yield of the crude trinitrotoluene in oxidation products soluble in Na_2CO_3 is about 0.6 per cent. The presence of acid bodies in crude trinitrotoluene shows that this explosive should not be treated as a neutral body except when it is pure. In the crude state it is, like picric acid, capable of forming explosive lead salts.

(b) Dinitro-benzene and trinitrometaxylene if the toluene used has not been completely freed from benzene and xylene.

We will now examine successively the action of dilute, cold, solutions of sodium sulfite on these different products.

Action on Assymmetric Trinitrotoluenes

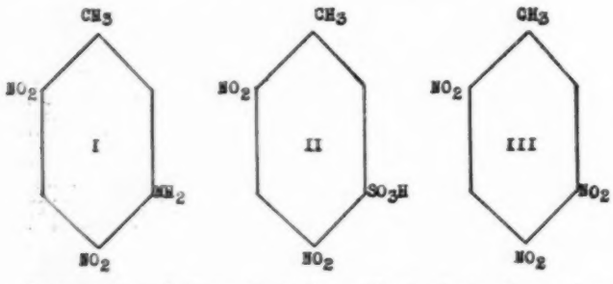
Aqueous solutions, containing 3 to 5 per cent of anhydrous sulfite, dissolve assymmetric trinitrotoluenes in the cold giving colorless solutions containing the corresponding sodium dinitrosulfonates. A nitro group in the ortho position to another nitro group is eliminated and replaced by a sulfo group, with formation of sodium nitrite. The assymmetric trinitrotoluenes are thus removed from the crude trinitrotoluenes by treatment with sulfite.

So far as concerns the Y-trinitrotoluene we have shown the following experimentally: The mother liquors from the treatment of the crude trinitrotoluene with sodium sulfite are acidified with HCl,[4] evaporated to dryness and the residue extracted with boiling alcohol. The insoluble NaCl is separated by filtration. By cooling the alcohol solution the sodium salt of the sulphonic derivative is deposited and may be purified by recrystallization from alcohol. To obtain a very pure product, the sodium salt is transformed into a barium salt, which may be recrystallized from water in which it is but slightly soluble in the cold. From 800 grms. of a trinitrotoluene made at Saint Fons we have obtained 17 grms. of the sodium salt.

The sodium salt of the sulphonic derivative may also be obtained from the mother liquor by acidifying with HCl and precipitating out by saturating the concentrated solution with common salt. The sodium salt obtained gives the reactions of a dinitrosulfonic acid derivative and by reduction, it gives rise to a diamine sulfonate.

Determination of the Constitution

By boiling the barium, or better the sodium, salt with ammonia we have obtained, by the substitution of the amido for the sulfo group, the corresponding dinitrotoluidine with m. p. at 194-195° which we have identified as the 3—amino—4, 6—dinitrotoluidine (I).



It therefore follows that the sulfonic derivative existing in the mother liquors has the formula (II). This sulfonic derivative can not be formed except by substitution of a sulfo for a nitro group in the Y-trinitrotoluene (III) under the influence of the sodium sulfite. The truth of these conclusions is confirmed by:

(1) Transforming pure Y-trinitrotoluene into its sulfonic derivatives by treatment with sodium sulfite. The sodium salt of this derivative was purified by crystallization from alcohol. The corresponding barium salt is but slightly soluble in cold water. The sodium salt on treatment with ammonia yielded a dinitrotoluidine (m. p. 193-195°) identical with product obtained above. (2) Direct treatment of the trinitrotoluene in solution in acetone by ammonia. By substitution of an NH_2 for an NO_2 group we have obtained the same dinitrotoluidine as above.[5] There cannot then the least doubt exist as to the parent substance of the sulfonic derivative isolated from the mother liquors by treatment with sulfite; this substance has been formed from the Y-trinitrotoluene.

We have also operated with synthetic mixtures:

(A) 200 grms. of pure trinitrotoluene, (setting point 80° .4), were fused and 6 grms. of Y-trinitrotoluene added giving a mixture having a s. p. 78° .5. The mass was cooled, pulverized and treated in the cold, during one hour, with 200 cc. of an aqueous solution liberating 3 per cent of anhydrous sulfite. The setting point of insoluble trinitrotoluene, after washing and drying, was 79° .5. The mother liquor acidified, evaporated and the residue extracted with alcohol, yields the Na salt of the sulfonic derivative formed from the Y-trinitrotoluene.

(B) There was treated in a similar manner a mixture of 200 grms. of pure TNT and 6 grms. of β-trinitrotoluene, the setting point of the mixture being 78° .5. The washed and dried insoluble trinitrotoluene had a setting point of 79° .4. The mother liquor was acidified and evaporated, and extracted with warm alcohol. No precipitate whatever is produced on cooling the alcoholic solution, but on evaporation a syrup is obtained which contains the sulfonic derivative formed from the β-derivative.

It is to be observed that in these two tests the sulfite did not completely eliminate the assymmetric trinitrotoluene; the reason for this is indicated farther on.[6]

Action on Tetranitromethane

Tetranitromethane in contact with a cold dilute (4 to 5 per cent of anhydrous sulfite) sulfite solution is rapidly dissolved with an elevation of temperature. The attack on this body is much more energetic than on the assymmetric tolites and it is certain that in the course of the purification of tolite by sulfite the tetranitromethane disappears very rapidly. What is the mechanism of this reaction? The most plausible hypothesis is that of a reaction analogous to that of the sodium sulfite on assymmetric trinitrotoluene; (substitution of a sulfonic for a nitro group) thus obtaining by the following reaction

$$C(NO_2)_4 + Na_2SO_4 \rightarrow C(NO_2)_3\,SO_3Na + NaNO_2$$

[4]When the mother liquors from the sulphite treatment are acidulated two conditions may arise (1) the liquid may give reactions for nitrous acid, or (2) for sulfurous acid. This last condition does not occur when the proportion of sulphite to soluble isomers used is in excess of 50 per cent. The action of the sulfite on the trinitro derivatives gives rise to the formation of the $NaNO_2$ as follows:

$$R\begin{cases}NO_2\\NO_2\\NO_2\end{cases} + Na_2S_2O_5 \rightarrow R\begin{cases}NO_2\\NO_2\\SO_2Na\end{cases} + NaNO_2$$

and in acidifying 1 molecule of Na_2SO_3 is required to neutralize 2 molecules of nitrous acid as the latter is reduced to nitrogen dioxide.

[5]The β and γ-trinitrotoluenes used in this research were prepared and presented by Mr. Yovinet, Chemist at the Laboratoire Central des Poudres. We take this opportunity to thank him.

[6]On treating crude trinitrotoluene with alcohol the β and γ-trinitrotoluenes are dissolved. It is interesting to note that on the addition of aniline to the alcoholic solution there is obtained, on rapid cooling, a precipitate of dinitrotolylphenylamine formed by reaction of the aniline on the γ-trinitroluene.

the sodium trinitromethane sulfonate which is soluble in water.

As a fact the reaction is much more complex for the preceding equation implies the maintenance of neutrality while really the solution turns acid very quickly and disengages nitrogen dioxide. These phenomena appear to be explained in the following manner. In the first phase of the reaction sodium trinitromethane sulfonate will be formed but, being an unstable compound, it becomes hydrolyzed as follows:

$$C\begin{cases}(NO_2)_3\\SO_3Na\end{cases} + H_2O \rightarrow C\begin{cases}(NO_2)_3\\H\end{cases} + HNaSO_4$$

through which trinitromethane and sodium bisulfate are formed.[7] The reaction of these products with the sodium nitrite formed in the first reaction will give rise to nitrogen dioxide. In order to confirm these views, we have sought to identify the trinitromethane.

The yellow solutions obtained present the characteristics of this substance, in being decolorized by concentrated acids and in imparting its color, by entrainment, to the vapor of water. To identify the trinitromethane we have operated in the following fashion. Three cc. of tetranitromethane were treated with a solution of 10 grms. of sulfite in 100 cc. of water, the yellow colored solution acidified by H_2SO_4 and then extracted by ether. The ethereal solution was treated with an excess of silver oxide until the reaction was neutral and the ethereal solution was decanted and evaporated. We have thus obtained the explosive silver salt of tetranitromethane described by Hantzsch and Rinchenberger (Ber. v. 32, pg. 636 [1899]), whose solubility in ether may be regarded as a characteristic.

To resume (1) Tetranitromethane readily reacts on contact with sodium sulfite in aqueous solution, (2) the reaction appearing to take place in two phases: A, the formation of sodium trinitromethane sulphonate, and, B, the hydrolysis of this product with the formation of the sodium salt of trinitromethane.

Action on Trinitrobenzene

Trinitrobenzene is dissolved in the cold in dilute solutions of sodium sulfite. These solutions, colored an intense red, do not contain a derivative sulfonate but an addition compound. On destroying the sulfite by acidification, or oxydation, with iodine, or hydrogen dioxide, the trinitrobenzene is recovered unaltered. We will return to this reaction farther on.

Action on the Oxidation Products

Dilute solutions of sodium sulfite easily dissolve the oxidation products which exist in crude TNT. The explosive, brown salts of lead, which are nearly insoluble in water, are easily dissolved in dilute solutions of sulfite. Such solutions may be used to great advantage in washing of lead worms covered with these salts.

Action of Sulfite on the Other Impurities in TNT

Dilute solutions of sodium sulfite do not act in the cold on dinitro derivatives of toluene, or on dinitrobenzene. We believe also they do not act on trinitrometaxylene. Hence, such of these impurities as exist in trinitrotoluene are not eliminated by treatment with sulfite.

Action of Sodium Sulfite on Pure TNT

It is important to remark that sodium sulfite does not act on pure trinitrotoluene. We have seen that trinitrobenzene gives birth on contact with solutions of sodium sulfite to an addition compound which is soluble in water. Trinitrotoluene reacts in an analogous manner but the addition compound formed *is not stable when the sulfite solution is concentrated.* On diluting the solution the greater part of the trinitrotoluene reprecipitates in the pure condition. Hence dilute solutions of sulfite do not dissolve but minute quantities of trinitrotoluene. The solubility of pure TNT in sodium sulfite solutions was experimentally demonstrated as follows:

> (1) 30 grms. of pure TNT (s.p. 80°.1) were treated for 1 hour with 100 cc. of a solution containing 3 per cent of anhydrous sulfite. The filtrate gave a faint precipitate on dilution. The undissolved TNT was washed, dried and weighed. Weight recovered, 29.7 grms. Dissolved, 0.3 grms. (2) 30 grms. of pure TNT were treated under the same conditions as above with 100 cc. of a solution containing 6 per cent anhydrous sulfite. The filtrate was strongly clouded by dilution. Weight recovered, 29.1 grms. Dissolved, 0.6 grms. (3) 30 grms of a pure TNT were treated with 100 cc. of a solution, containing 12 per cent of anhydrous sulfite, *during 12 hours.* The filtrate gave a heavy precipitate on dilution. Weight recovered 27.7 grms. Weight of TNT dissolved 2.3 grms. The washed TNT contained some red spots due to the penetration of the sulfite into the interior of the grains; but its solidification point was 80°.5. This long treatment of the TNT with concentrated sulfite had not then changed the trinitrotoluene whatsoever.

The formation of strongly colored, water soluble, addition compounds with sodium sulfite *seems to be a general reaction of symmetric trinitro derivatives* and appears to establish a relation between the sensitiveness of the substances to aqueous caustic soda and the readiness of the sodium sulfite to dissolve the colored sodium salt as soon as it is formed. It is interesting to note that the introduction of CH_3 groups in the molecule opposes this reaction as judged from the following data: *Trinitrobenzene, symmetric.* Strong reaction in caustic soda solution; extremely soluble in sodium sulfite; addition derivative stable even in dilute solution.[8] *Trinitrotoluene, symmetric.* Moderate reaction with NaOH; moderately soluble in sulfite solutions; addition derivative is dissociated by dilution. *Trinitrometaxylene, symmetric.* No reaction with aqueous soda but only with alcoholic soda. No reaction with solutions of sodium sulfite. *Trinitromesitylene.* No reaction even with alcoholic soda. No reaction with sodium sulfite.

It is seen to be possible to separate a mixture of trinitrobenzene, trinitrotoluene and trinitrometaxylene by treating first with a dilute solution of the sulfite, which dissolves the trinitrobenzene and traces of trinitrotoluene, then by concentrated sulfite solutions, which remove the trinitrotoluene, which can be recovered by dilution. The trinitrometaxylene remains as an insoluble residue.

Results Obtained in the Treatment of Industrial TNT

As a gage of purity there is given the solidification points observed in treating, under different conditions, different samples of crude industrial trinitrotoluenes,

[7] It is possible that this reaction is due to an autocatalysis, the first traces of acid formed favoring the hydrolyses of the trinitromethane sulfonate. Perhaps the yellow solution, obtained in making an ammoniacal solution of the sulfite reacts on tetranitromethane, contains unaltered sodium trinitromethane sulfonate. This point remains yet to be proven.

[8] Solutions containing the addition products of trinitrobenzene and trinitrotoluene appear to be modified by time, without doubt following the transformation of addition derivatives to sulfonic derivatives.

after they had been washed with warm water. *Sample No. 1.* Made at Saint-Fons, s.p. 77°.1. Material pulverized but not sifted. After treatment for 1 hour with a 3 per cent Na_2SO_3 solution, s.p. 79°.85. After treatment for 1 hour with a 6 per cent Na_2SO_3 solution, s.p. 80°.2. After treatment for 16 hours with a 3 per cent solution, s.p. 80°.1. This product treated for 1 hour with a 6 per cent solution was fused, pulverized anew and then treated for 1 hour by a 3 per cent solution, s.p. 80°.2. The sample, preserved after treatment with sulfite, had a light salmon color. *Sample No. 2.* Made at Saint Chamas. s.p. 78°.3. After treatment for 1 hour with a 3 per cent sulfite solution, s.p. 80°.2. After treatment for 1 hour with a 6 per cent solution. s.p. 80°.2. After treatment 10 hours with a 3 per cent solution. s.p. 80°.25. The product, after treatment for 1 hour with a 6 per cent solution, was fused, pulverized anew and treated for 1 hour with a 3 per cent sulfite solution. s.p. 80°.35. The TNT thus obtained was white.

Pure TNT obtained by crystallization from alcohol has a solidification point of 80°.4. The TNT obtained by treatment with sodium sulfite is not then quite as pure as that obtained by crystallization from alcohol but the degree of purity attained appears sufficient for most of its applications.

One observes that the solidification points obtained in these tests are distinctly higher than those obtained in the experiments cited above in which mixtures of pure and assymmetric trinitrotoluenes, prepared in the laboratory, were made use of. In these last tests a mixture having a s.p. of 78°.5, after treatment for 1 hour with a solution titrating 3 per cent sulfite, gave a trinitrotoluene with a s.p. of 79°.5.

We have sought the origin of this curious difference and have found it in *the heterogeneity of commercial trinitrotoluenes.* We have established that in these the assymmetric derivatives are distributed in an irregular manner throughout the mass. This heterogeneity originates in the separation taking place during the slow cooling of the product. By cooling slowly 500 grms. of crude trinitrotoluenes (s.p. 78°.5) produced at Saint-Chamas, and removing the central liquid portion before complete cooling was reached, we have proven that the needles formed had a s. p. of 79°.5. There was then a separation of relatively pure TNT and of a true eutectic rich in assymmetric trinitrotoluene. The lack of homogeneity of the crude trinitrotoluene can be demonstrated in a very simple manner. If some of this trinitrotoluene is pulverized on a sieve, the eutectic, being the more friable, passes through the mesh first, so that the residue left on the sieve is purer than the portion that has sifted through it. In treating 40 grms. of crude trinitrotoluene (s. p. 77°.7), from Saint-Fons, in this manner we have obtained 30 grms. of the sifted product having a s. p. of 77°.2 and 10 grms. of residue having a s. p. of 78°.8. The separation then is quite sharp.

This formation of a eutectic explains the difference observed in the action of sodium sulfite on different commercial trinitrotoluenes. It appears that the eutectic, perhaps because it is readily disintegrated, is easily attacked by the sulfite. In the synthetic mixtures, prepared in the laboratory, the cooling being very rapid, the assymmetric trinitrotoluene is distributed throughout the mass and thus protected, in some measure, from the action of the sulfite. From the foregoing, it follows that a crude trinitrotoluene which may be easily purified by sulfite, will, when fused, cooled rapidly, and then pulverized, be purified less readily.

This is shown by the results of the following experiments: (1) 35 grms. of crude trinitrotoluene from Saint-Fons, (s. p. 77°.1), were pulverized in a mortar and treated for 1½ hours with a 3 per cent sulfite solution. The product had a s. p. of 80°.(2). Similar treatment of 35 grms. of the same specimen, which had been fused and pulverized, gave a product which had an s. p. of 78°.9. This difference was not due to a less complete pulverization of the trinitrotoluene in No. 2 experiment. As a fact, the Saint-Fons as received, *without pulverization* (in coarse powder) when treated under the same conditions gives a product having an s. p. of 79°.4. In the process which consists in granulating the trinitrotoluene by running it into cold water the eutectic is not separated; hence, the tolite thus obtained is more difficult to purify by sulfite than the tolite which has been cooled slowly.

In order to obtain the maximum efficiency in the sulfite treatment it is essential to use a trinitrotoluene which has been cooled slowly and in which there has been formed a true eutectic rich in assymmetric derivatives and in impurities.

Analytical Utilization of the Sulfite Reaction

We have used the reaction of sodium sulfite on trinitro derivatives for, (A) To make an approximate determination of the quantity of assymmetric trinitrotoluenes contained in the crude TNT, and (B) To effect the separation and approximate determination of the mixtures of di- and trinitroxylenes produced by the nitration of crude xylenes.

(A) An operative method for the approximate determination of assymmetric trinitrotoluenes in crude TNT is based on the difference in the action of sodium sulfite on symmetric and on assymmetric trinitrotoluenes. The loss in weight of a treated TNT does not give a very precise indication because loss is partly due to the removal of other impurities and to the solution of a part of the symmetric trinitrotoluene.

The method we have studied is embodied in the following:

(1) Sodium sulfite can be titrated in a bicarbonate solution by an iodine solution with a precision which, though not very great, is sufficient for the case under consideration, viz., a sodium sulfite giving 100 per cent when liberated in acid solution, which is an exact method, gave a titre of 94 per cent in a bicarbonate solution. (2) The sodium sulfite in the addition compounds formed by the action of sodium sulfite on the trinitrobenzene and trinitrotoluenes can be titrated with an iodine solution as it is set free. The trinitro derivatives which are released separate as a precipitate. (3) The dinitrosulfonates derived from the β and γ-trinitrotoluenes do not react with iodine to any apparent extent, or, at least in operating as described below. (4) The sodium nitrite formed by the action of the sulfite on the β and γ-trinitrotoluenes does not react with iodine in alkaline (bicarbonate) solution.

If then a trinitrotoluene, O, previously washed with bicarbonate by which to eliminate the oxidation products, is brought in contact with a standard solution of sulfite, the titration of the filtrate from this with iodine will indicate the weight of sulfite fixed by the assymmetric trinitrotoluenes present and, consequently, the proportion of these bodies present in the tolite analyzed.

Causes of Errors in the Application of the Method

(1) The sodium nitrite formed in the reaction (assymmetric trinitrotoluenes + Na sulfite) tends to lower the apparent titre for the sulfite, due, without doubt, to a

slow decomposition taking place under the action of hydriodic acid, in spite of the presence of a great excess of sodium bicarbonate. (2) The addition compound (symmetric trinitrotoluene + Na sulfite) shows a tendency to transform into a sulfonate. This transformation is promoted by an elevation in temperature, while brisk agitation acts in the same way. (3) Dilute solutions of sulfite are very rapidly oxidized by contact with the air (100 cc. of a standard solution, containing 3 per cent of anhydrous sulfite, lost 50 per cent in 12 hours). The first of the above causes is probably negligible. The other two may be in greater part suppressed by effecting the comparative treatments with a standard sodium sulfite plus pure symmetric trinitrotoluene.

Method of Operating

The operations are carried out with 20 grms. of finely pulverized and sifted trinitrotoluene which is introduced, with 30 cc. of a sulfite solution, containing about 3 per cent of anhydrous sulfite, into a flask. The flask is closed and shaken vigorously, to ensure complete mixing and left at rest for 1 hour, with agitation anew after ½ hour of rest. (More prolonged agitation does not appear to promote any further transformation of the addition products of the trinitrotoluene into sulfonic derivatives.) On filtration 5 cc. of the filtrate are reserved to be titrated with a 1/10-N solution of iodine. It is useless to employ starch, the color change being quite sharply shown by the decolorization of the solution (due to decomposition of the colored addition compounds) and the color resulting from the very slight excess of iodine solution. One may also use as an indicator a drop of carbon tetrachloride which acquires a violet color with the least trace of free iodine. If the standard absorbs N cc. and the material under test absorbs n. cc. the difference, N-n, corresponds to the sulfite fixed by the assymmetric trinitrotoluenes. (One cc. of the iodine solution equals 0.0063 grms. of sulfite, or 0.01135 of assymmetric trinitrotoluene.)

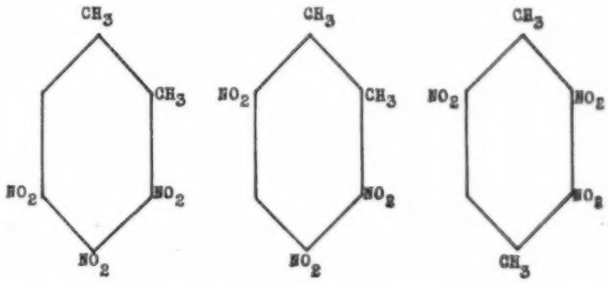
We have, by this method, found in crude commercial trinitrotoluenes from 2 to 4 per cent of assymmetric trinitrotoluenes. These variations are probably due to the fact that spent acids, containing assymmetric trinitrotoluenes in solution, have been used in the nitration of new material.

[9]Proportions 20 grms. xylite, 8 grms. anhydrous sulfite, 100 cc. of water. Heated 5½ hours at 70°.

Utilization of the Sulfite Reaction for the Separation and Approximate Determination of the Trinitro Derivatives of Xylene

(B) We have already recorded the remarkable insensibility of trinitrometaxylene to the action of sodium sulfite. This trinitro derivative resists attack by dilute solutions of sulfite even when heated to 70°.

This is, however, not the case with the trinitro derivatives of the ortho and the para xylenes



which, each possessing two nitro groups in the ortho position, should be acted upon by the sulfite. As a fact by treating a mixture of the trinitro derivatives, obtained by nitrating crude xylene with strong mixed acids, with warm dilute solutions of sulfite, we have obtained pure trinitrometaxylene.[9]

We may utilize the sulfite reaction for the approximate analysis of even more complex mixtures containing di and trinitro derivatives of ortho and para xylenes and trinitrometaxylene. The first treatment with sulfite admits of the approximate determination of the content of trinitro derivatives of the ortho and para xylenes. The insoluble residue is treated with alcohol which dissolves the dinitro derivatives. The trinitrometaxylene remains as a residue.

This method has been utilized during the war for the characterization of the mixtures (xylites) obtained by nitrating crude xylenes. Without any pretension to great exactitude, it permits of differentiating and classifying mixtures whose complexity is very great and, for this reason, we have believed it worthy of presentation.

Editor's Note: The complete title of M. Muraour's paper as published in "Bulletin de la Societe Chimique de France" as "Action of Sodium Sulfite on Some Trinitro Derivatives and on Tetranitromethane; Purification of Tolite." In French usage TNT is designated "Tolite."

Preponderance of Munitions in Modern Warfare

"IF the work which is now under way in regard to industrial preparedness had only been undertaken a year before our entrance into the World War, there is no doubt in my mind but that the Armistice would have been advanced by several months, with the resulting saving of a tremendous amount of money and the avoidance of the loss of many valuable lives.

"It is only fair to state, however, that a few of us realize the preponderant part played by munitions as contrasted with personnel in modern warfare, but now that we do know, it would be sure folly not to profit by the lessons of our most recent experience, and so plan that our man-power can be properly matched with adequate munition power in any future emergency."—*General John G. Harbord, President, Radio Corporation of America, former Deputy Chief of Staff, U. S. A.*

The Standardization of Optical Fire Control Instruments*

By

I. C. GARDNER

SINCE the close of the World War it has become a truism that the military power of a country depends to a very large measure upon the extent and variety of its industries and its ability to utilize them when a military emergency arises. During the past war the production of optical instruments for military purposes, because of its peculiar difficulties assumed an importance far out of proportion to the expenditures involved. New methods of warfare made necessary the prompt development of new instruments of complicated and elaborate design and any improvement in the facilities for laying guns or other offensive weapons meant at once a great increase in the efficiency with which they could be used, thus lessening the demand for ammunition and matériel, with a consequent decrease of the strain on the industries producing such equipment. Now when we are so far removed from these previous activities as to have a more correct perspective, it seems proper to review the history of the production of optical instruments during the war, and to determine just what means might be adopted in order to better conditions if a future emergency should arise.

Optical Glass Production

The production of optical glass which is the raw material for the manufacture of lenses can be dismissed briefly. This was very ably discussed by Major H. K. Rutherford in the July-August, 1924, issue of ARMY ORDNANCE, "Optical Glass: A Strategic Raw Material," Vol. V, page 423. Prior to our entry into the war the government had recognized the importance of a domestic source of optical glasses and the Bureau of Standards had started a small plant located at Pittsburgh, where experimental work had been begun. Shortly after the declaration of war the services of the Geophysical Laboratory of the Carnegie Institution of Washington were enlisted and its experimental work began at the plant of the Bausch & Lomb Optical Co., Rochester, N. Y. At the end of the war optical glass of acceptable quality and in large quantity was being produced by the Bausch & Lomb Optical Co., the Spencer Lens Co., Keuffel & Esser, one of the plants of the Pittsburgh Plate Glass Co., and the Bureau of Standards. The supply of glass was large enough to take care of the current needs and the country now finds itself well supplied with potential sources of optical glass and with a corps of scientific men which is sufficiently well informed to begin the production of glass upon short notice. Experimental work is still being carried on at the plant of the Bureau of Standards which has since been moved to Washington, and in addition to its research work this plant is furnishing a large supply of glass for the use of the Navy.

The history of the production of lenses, prisms and optical instruments is an interesting one, well worth studying if past errors are to be avoided in the future. The intensive fighting along a stationary front increased the demand for fire control apparatus far beyond any one's expectation. Many of the more complicated fire-control instruments which were in the possession of the Army prior to our declaration of war had been imported from Germany and much of such equipment manufactured in this country had assembled in it optical parts which had been brought in from that same country. The Ordnance Department of the Army had at Frankford Arsenal a well equipped optical shop and had built some military fire-control instruments, but the enormous requirement for optical instruments which developed as soon as war was declared was, naturally, too great for this one small shop.

The Allies had become hard pressed for sources of optical matériel and had therefore given large contracts for field glasses and some of the simpler optical instruments to American firms. Immediately upon the declaration of the war by the United States it was realized that greatly increased supplies of fire-control instruments would be necessary; therefore, at once orders were placed for quantities of the older types of fire control instruments. We were already familiar with the construction of these instruments and orders for them were placed with our best and most experienced optical establishments. The war had lasted but a short time when it was apparent that we should need enormous numbers of the newer types of fire control instruments which had been developed as a result of the changed character of warfare and the introduction of new agencies, but unfortunately when this phase arrived our firms best able to cope with the design of new instruments were already using all of their available resources to produce the older types of instruments which were first ordered. Consequently it was necessary for the government to persuade firms having the necessary material equipment to accept contracts for these newer instruments. These firms responded most patriotically to the demands made upon them. This country has firms unrivaled elsewhere in the production of small mechanical parts and once the degree of accuracy required in the construction of military optical instruments was appreciated there was no difficulty in producing the mechanical parts of instruments in sufficiently large quantities. But these firms necessarily could not be expected to have engineering staffs capable of handling the new optical problems which arose. Nor could the government for its own staffs secure the scientific body which it should have liked to have had because the supply of optical engineering knowledge in this country has always been somewhat limited, and further, the established optical firms had contracted all available personnel prior to our entry into the war when they had first begun to receive large orders from abroad. As a result of this situation which in retrospect appears perfectly natural and inevitable, there was much confusion

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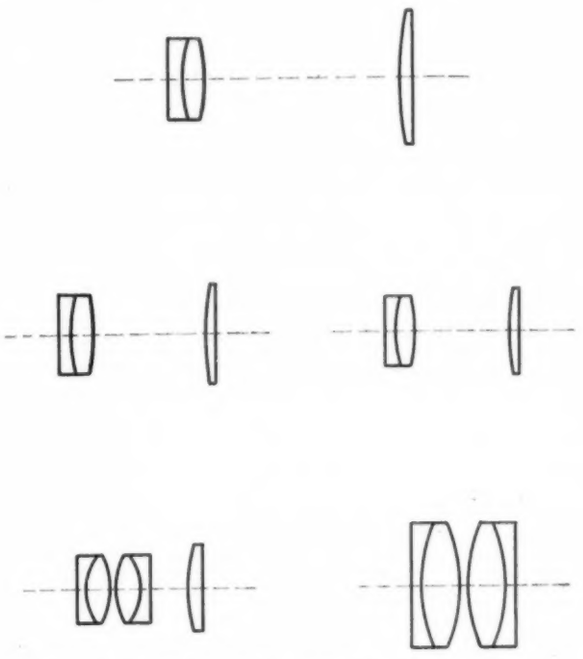
and some inadequacy in the production of the optical components for fire-control instruments. Furthermore, in many cases drawings for the newer instruments were received from abroad and were put into production here without any modifications to adapt them to American methods of manufacture. This in the long run was a



Diagrammatic Drawing Showing Eyepieces Required by Original Tentative Scheme for Standardization Developed by Technical Staff of the Ordnance Department

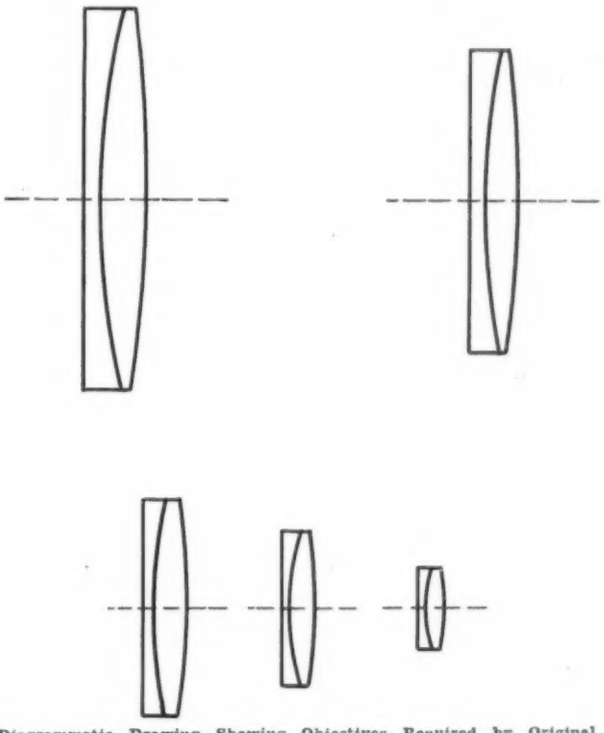
grave mistake, since methods of production here are essentially different from those abroad. In other cases instruments developed here by certain firms were designed to use optical parts which they already employed in peace-time instruments of their own manufacture. This, for immediate results at the time, was a good thing, but as a permanent policy it should not be continued, for all advantages of such a policy vanish so soon as a contract for these organizations is let to a firm other than its originator. Such standardization of fire-control instruments as is effected should be applied to all of the variety of army instruments as a unit.

Present Status of Optical Instruments

This brief history of the production of optical fire-control instruments during the World War is given not at all in a spirit of adverse criticism, but rather to show how in the natural course of events there was developed an unnecessary diversity, much of which has since been remedied. As a result of this, however, at the close of the war a list of the smaller fire control instruments, exclusive of range finders, used by the Army showed that there were 23 different instruments possessing a great variety of optical characteristics, and calling for 16 different objectives and 22 different eye-pieces. Considerable variation is, of course, essential because the requirements of the Army are varied, but in many cases the variation was entirely insignificant and had its origin either in the fact that some manufacturer had designed the instrument to use parts which he had already under production or because a design from abroad has been received and followed. Although the optical fire control instruments of the Army appear in many different forms, yet all of them optically are telescopic sighting systems, and the optical variation necessary is much less real than appears from a superficial inspection. It is necessary to decide upon a certain number of magnifications, which are considered as indispensable. For each of these magnifications, then, a standard optical system can be designed. True, different instruments having the same power require different prism systems, but even here in most cases the introduction of the prism makes unnecessary a new design of the lens. As a result of the preparation of a tentative scheme developed within the Technical Staff of the Ordnance Department, it was estimated that for future production the 23 different instruments then supplied with 16 different objectives and 22 different eyepieces could be replaced without introducing any considerable change in the final optical performance of the instrument by only six objectives and six eye-pieces.

A Plan for Standardization

It is believed that the optical staff of the Ordnance Department should make a new appraisal of the number of optical systems necessary to meet the demands of the Army, as there have necessarily been changes and innovations which require that the original scheme be modified and a new list of standard components constructed. This plan should then be adopted as a guide for future development work. The advantages of such a step will be far reaching. With so small a number of standard components, the optical designing staff of the Ordnance Department may concentrate its efforts upon the improvement of these components rather than upon the multiplication of different systems. Furthermore, tables may be prepared by which constructional data for these components may be made available in advance and which will enable a greater variety of glass to be efficiently utilized than was possible during the World War. With stand-



Diagrammatic Drawing Showing Objectives Required by Original Tentative Scheme for Standardization Developed by Technical Staff of the Ordnance Department

ardized components it becomes feasible to establish a pressing plant at the glass factory and to press all the glass as fast as it is produced into forms suitable for efficient utilization in the construction of lenses. This will enable all the small pieces of glass, which unavoidably occur, to be used in the construction of the small lenses instead of being wasted, as has frequently happened in the past because they were received by plants only concerned in the manufacture of large lenses. The manufacturer who takes an optical contract will receive his glass in the form of molded blanks carefully graded and invoiced to him. Thus the enormous waste which resulted during the past war through delivery of rough pieces of glass and pressed slabs will be entirely eliminated.

Advantages of Standardization

A plan for standardization as outlined above has everything in its favor and has in fact already been adopted informally as a part of the working program of Frankford Arsenal in the development work on new instruments. But it is believed that steps can be taken which will result in the further adherence to this scheme in the future and in the production of even better instruments. The work of the Technical Staff on standardization, which has already been mentioned was, at the time it was presented, admittedly tentative. And, furthermore, in its present status it is doubtful whether the plan would survive the shifting of personnel which, unfortunately, would probably take place in the event of military emergency. After the optical staff of the Ordnance Department has made a careful study of the requirements of the different optical instruments and listed the different systems and components required, the question of design is narrowed down to a satisfactory working basis and it becomes not only possible but advisable to have each of the standard optical systems made and carefully mounted in a plain tube. These systems would in no sense be fire control instruments, but would represent the optical systems available when a new sight is to be developed and would make the scheme for standardization a tangible entity.

Furthermore, a new instrument under development must necessarily be to some extent an unknown quantity until it has actually been submitted to test. With the variety of standard optical systems already constructed and ready for examination the unknown factors in the development are reduced and those interested in the development work who are not trained optical engineers can be given exact and complete information regarding the optical performance of the future instrument as can be done in no other manner. The development of the mechanical parts can then proceed separately and it, too, will be to some extent subject to the demands of standardization. But in general in the past these demands so far as mechanical parts have been concerned, have been better handled than have the demands for standardization of optical components. It is, of course, not intended that any of this plan for standardization be retroactive. There is no need to reconstruct the large quantity of instruments already in possession of the Ordnance Department. They are likely to be obsolete anyway before the demand for them in actual service arises, but with these standard optical systems decided upon and with models constructed the scientific staff of the War Department is presented with the definite problem of providing for future production of such systems on a large scale, and for any future emergency the production of optical fire control instruments can be undertaken much more smoothly than was the case in the past and will tend to follow naturally along a carefully selected plan for standardization.

Important Role of The Army Industrial College

THE Army Industrial College has an important part to play in connection with the industrial side of the War Department in time of war. Just as our service schools are developing officers for General Staff duties and tactical command, so this School was created by the Secretary of War for the purpose of instructing officers of the procurement branches in the higher duties of their profession in connection with procurement of supplies in time of war. Every staff officer of a supply branch with troops operating in the field must be conversant with the manifold difficulties of production in order that he may know that, if he does not forecast his requirements in time to insure delivery when needed, requisitions are useless. As the College grows in numbers and develops increased efficiency in its curriculum and methods of instruction, it will probably become necessary to extend the length of the course and provide it with a faculty whose whole time can be devoted to instruction.

It is for you who have had an opportunity of studying these matters and for those who will come after you, as well as for officers engaged on procurement planning, to read, study and apply the lessons of the World War as set forth in the few extracts above quoted, and by numerous others with which you are now acquainted. Let me urge you to take advantage of every opportunity of studying the methods used by industrial establishments in planning programs and executing them, while retaining control of the same at every stage of progress. Corporations who fail to do this either produce no dividends or ultimately go into bankruptcy.

All of our engineering schools today carry courses in Industrial Management and in every city there are consulting engineers who are paid big fees for giving advice to industrial establishments who have not sufficient ability or experience to plan their work and execute it without losing control. Control through planning is one of the outstanding features of American industrial life at the present moment because industrial leaders in this country must plan with utmost care in order to produce dividends on their capital investments while retaining for American labor the high standards which everyone wishes to see it enjoy.

In the same way in which industrial engineers are planning, executing and controlling production, the procurement branches of the War Department must ascertain what they want and plan where and how to get it, while retaining control of the orders placed and deliveries made thereunder. The Assistant Secretary of War, in time of war, will want to know, every day, the exact status of requirements and deliveries.—*From the Address of Col. Dwight F. Davis, Assistant Secretary of War, to the first graduating class of The Army Industrial College, June, 1924.*

Concerning the Nature of Detonation

By

FRED OLSEN

WHEN a high explosive such as TNT or Tetryl detonates there is a sudden disruption of the substance which is conceived to be sufficiently thorough to involve the complete shattering of the bonds which hold together the atoms of the substance. It is improbable that TNT, for example, breaks up fundamentally into the gaseous products of decomposition which are found when an examination is made of the contents of a closed bomb. It is rather to be considered that the substance is primarily broken up by detonation into its elements which thereupon rearrange themselves into the various observed gaseous products, such as carbon monoxide, steam, carbon dioxide, etc., simply because the conditions such as temperatures, pressures, concentrations, etc., attending detonation are favorable to the recombination of the elements.

When a propellant powder, however, burns normally in the chamber of a gun it is possible that the severing of the bonds between the various atoms in the molecule may be by no means as complete as in the case of detonation mentioned above. It is conceivable that the temperature of the flame as it eats its way into the powder grain is merely sufficiently high to sever the bonds of those parts of the nitrocellulose or nitroglycerin molecules which are nearest the flame, and this eroding of the nitrocellulose molecule may result in the splitting off of such unit groups as CO, NO_2, etc. The phenomenon is essentially a surface reaction, the burning of powder grains taking place in layers parallel to the original surfaces. These unit groups may be and probably always are involved in subsequent rearrangements or recombinations in the flame front; the nature of these recombinations depending on the conditions of temperature, pressure, etc., existing there at the moment.

The question with which we are vitally concerned in detonation is just what causes the interatomic bonds to break, and before attempting an answer to this question it is believed to be desirable to first inquire as to the probable nature of these interatomic bonds.

Through the work of several chemists and physicists there have been developed modern conceptions of the structure of the atom and of the nature of the chemical bonds holding together the atoms, which are so much in accord with a great mass of experimental data collected from widely varying sources that the probability of the correctness of these conceptions, at least in their more general aspects, is now very great.

The two names which stand out when the recent work regarding the structure of atoms and the nature of the chemical bond is considered are Nils Bohr, of the University of Copenhagen, and Gilbert N. Lewis, of the University of California. Bohr's contribution has provided us with a picture of the constitution of atoms which is very beautiful and comprehensive. The hydrogen atom, for example, is considered as consisting of a nucleus and one negative charge of electricity (known as an electron). The nucleus is of uncertain constitution but possibly comprises a single positive electrical charge known as a proton. The electron is considered as continuously mobile, travelling in orbits which are definitely oriented with respect to the nucleus, although Lewis prefers to regard these electronic orbits as not necessarily involving the nucleus as the center of circular orbits or as a focus of elliptical orbits. At least Lewis' conception of the more complex atoms assumes that the atomic nucleus is not necessarily in the plane of the electronic orbits. Each electron, however, may move in any of several orbits and is conceived to be at different energy levels when travelling in these various orbits. It may be briefly stated that the characteristic spectral lines result from the emission of energy when the electron jumps from one orbit to another orbit. The energy which is emitted during this phenomenon is proportional to the frequency and hence the wave length of the light emitted. It may be mentioned here that it is one of the essential features of Planck's quantum theory that the proportionality factor is the same for all wave lengths of light so emitted. Thus a definite quantity or (quantum) of energy is involved in the moving of an electron from any orbit to any other orbit.

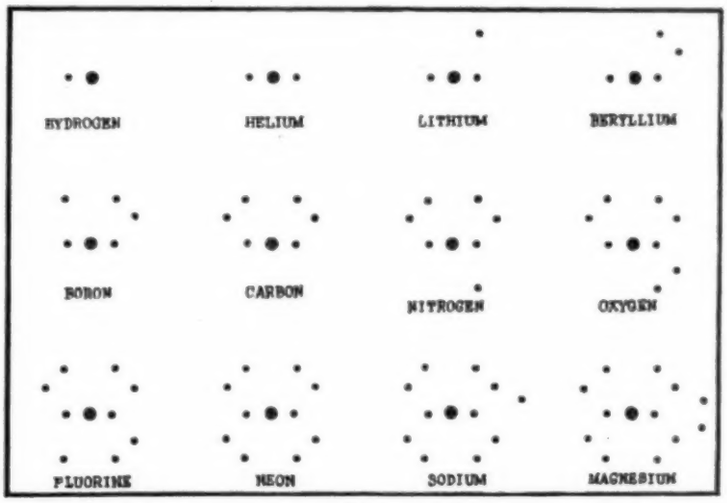


Fig. 1
The Heavy Central Dot Represents the Nucleus and the Light Dots the Electrons

If the chemical elements are considered in the order of their atomic numbers, which almost invariably coincides with the arrangement of the elements in Mendelejeff's periodic classification, it is conceived that each

element is more complex than the preceding element by the possession of one proton and one electron. The protons are at present usually considered merely as comprising the nucleus without consideration being given to any specific arrangement of the protons within the nucleus. The electrons, however, are conceived as having a very definite configuration, based upon the rather well established principle of the pairing of electrons, and also the frequent tendency of the paired electrons to arrange themselves in octets. Thus the first dozen of the elements are considered to have the electronic configurations shown in Fig. 1.

It will be noticed that the rule seems to be first a pair of electrons associated with the nucleus, then the gradual building up of a first shell of eight electrons in pairs until the atom contains ten electrons. The subsequent additions of electrons follow the same general practice of occurring in pairs until a second octet or shell of eight electrons has been added. It is not considered

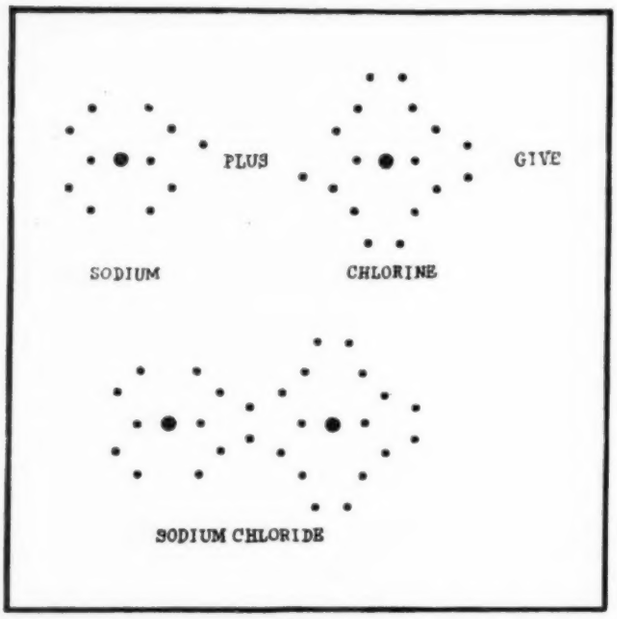


Fig. 2

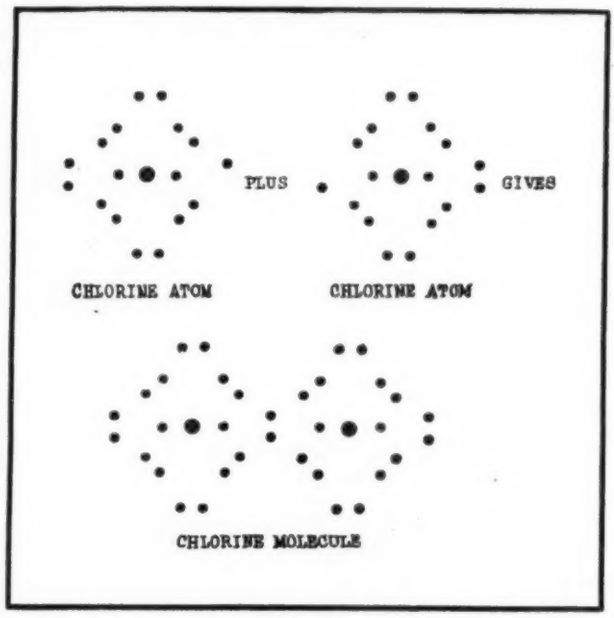


Fig. 2a

desirable here to elaborate upon the principles of the valence electrons but merely to mention that the electrons in the outermost shell are considered to be valence electrons, except in the case of the rare elements, in each of which case the octet is complete.

The distinct contribution of Gilbert N. Lewis is that the chemical union of two elements involves the sharing by their atoms of a pair of electrons (perhaps valence electrons). Thus the formation of a sodium chloride molecule is conceived to be the sharing by the sodium atom and the chlorine atom of a pair of electrons, as shown in Figs. 2 and 2a. This sharing of electrons may not be equally thorough in all cases and it may be that the difference between the very stable compounds and explosive substances, for example, lies in the completeness or tenacity of this electron sharing. In other words, in explosive materials these electrons may not be as firmly associated as in the case of inert materials.

It is proposed to make a study of the nature of these inter-atomic bonds by making use of some form of electron tube. The general principle of this tube may be illustrated by its application to the determination of resonance and ionization potentials. At one end of an evacuated tube (as in Fig. 3) a heated filament liberates electrons, just as in the case of the ordinary radio tube, which electron may be drawn over to a plate or target at the other end of the tube, if a suitable difference in potential between the filament and the plate is maintained. The velocity with which the electrons travel between the filament and the plate increases as the potential difference between the filament and the plate is increased. If atoms of some gas are present in the tube the electrons may collide with these atoms elastically and arrive at the plate without loss in kinetic energy provided the velocity of the electrons is not too high. As the velocity is increased, however, a glowing is observed in the tube and characteristic lines in the spectrum of these atoms may be observed. This emission of light is due to the imparting of sufficient kinetic energy to certain electrons in the atoms to cause these electrons to jump to other orbits than those in which they are travelling normally. This kinetic energy is, of course, given to them by the bombardment of the electronic stream, and the critical potential difference at which this phenomenon of the emission of light is first observed is known as the resonance potential for the particular atoms. A second pronounced change in the kinetic energy of the electrons arriving at the plate is observed when the velocity of the electrons is sufficiently high to drive certain electrons from the atoms out of the sphere of influence of the atom, thus ionizing the atom. This critical potential difference is known as the ionization potential.

If now a sample of some explosive substance, such as lead azide, mercury fulminate, tetryl, etc., be placed upon the plate and a stream of electrons directed against this target there may exist a critical potential difference above which the velocity of the electrons will be sufficient to impart a kinetic energy to the electrons shared by two atoms to carry these electrons beyond the sphere of influence of these atoms; in other words, to sever one of the inter-atomic bonds of the molecule. It is anticipated that a higher electronic velocity will be necessary in

order to effect the disruption of the bonds in tetryl than in the more sensitive mercury fulminate. Similarly TNT should require a higher velocity stream, and ammonium pierate still higher.

It is believed that by noting these critical potential differences, or rather the critical velocities of the bombarding electrons, a set of indices can be assigned to explosive substances which will serve as a quantitative means of describing their relative sensitivity to detonation. The occurrence of detonation will probably be detected by a flash of light which may be distinctly visible to the naked eye even though very small quantities of the explosive are under test. It may even be possible to detect the occurrence of detonation by observing through a spectroscope characteristic lines of the mercury or other elements in the explosive which would be liberated by the disruption of the molecule. These atoms in a high velocity stream of electrons would in all probability be energized to such an extent that spectral lines will be apparent.

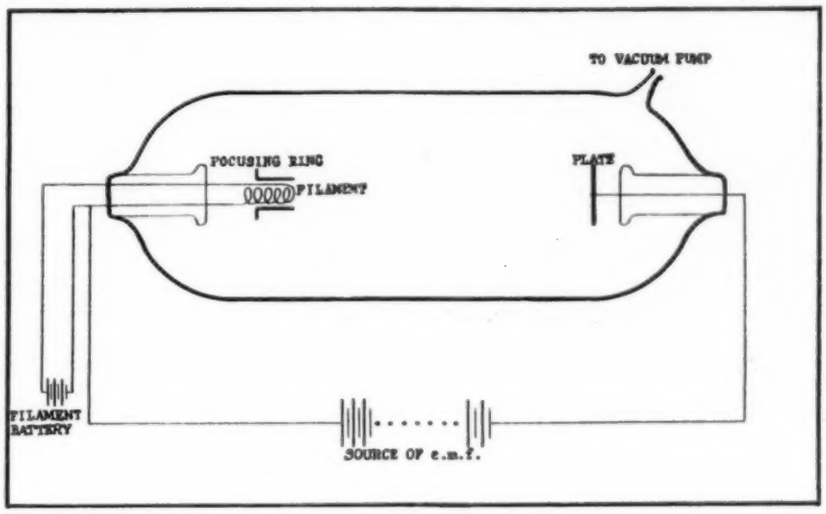


Fig. 3

The suggestion has been made that a strong potential difference might be maintained between the target and a surrounding metal shell which would force the electrons liberated by the disruption of the molecules of the explosive into the conducting system (somewhat of the nature of a condenser), leaving the atoms resulting from the molecule disruption in a neutral condition in which recombination is impossible. In other words, it may be feasible to actually trap the elementary units into which the explosive molecule is broken at the time of detonation. It would be much more significant to identify these units than to study the nature of the compounds produced by the recombination of these elements, as is usually done in bomb experiments.

It may be possible to develop apparatus which will permit the measurement of the velocity of electrons produced by the detonation of mercury fulminate, tetryl, TNT, etc. These velocities may perhaps be obtained by determining the critical potential difference required to bring the electrons to rest within a given distance from the point of detonation.

It is conceivable that a rather unique explanation of the action of booster explosives would be afforded if it were found that the critical velocity of an electronic stream necessary to effect detonation of an explosive such as ammonium pierate was higher than the velocity of the electrons emitted by the detonation of mercury fulminate. This would account then for the inability of mercury fulminate to effect the detonation of ammonium pierate. Since mercury fulminate is capable of initiating detonation in tetryl, it is assumed that the critical velocity of the electronic stream necessary to bring about detonation of tetryl is lower than the velocity of the electrons produced by the disruption of mercury fulminate molecules during detonation. The action of the booster explosive tetryl would then be apparent. It would mean that the velocity of the electrons produced when tetryl detonates is higher than the critical velocity required to effect detonation of ammonium pierate. If the critical electron velocities required to bring about detonation were known for each substance, and also if the velocity of the electrons emitted when each material detonates was known, it should be possible to select the appropriate initial detonating agent and booster substance for each explosive.

This electronic conception of detonation and the proposed means of investigating its validity should afford a valuable means of studying the nature of the chemical bond. Previous investigators have confined their attention to a study of non-explosive substances in which the stability of the chemical bonds between the atoms is very pronounced. For example, the very fact that sodium chloride is so stable chemically is indicative of the firmness with which the shared electrons are held within the sphere of influence of the sodium and chlorine atoms. Explosive compounds, on the other hand, are admittedly those in which certain of the inter-atomic bonds at least are weak. An effort should therefore be made to subject a series of substances to bombardment by streams of electrons in order to determine the kinetic energy which the electrons must have in order to break the chemical union between the atoms. Thus by a study of the various metallic azides the relative strength of the bonds between nitrogen and the various metallic elements should be revealed, and it would indeed be interesting if the strength of these bonds were found to be a periodic function of the atomic numbers of the various elements. Where an explosive comprises more than two kinds of atoms it may be found that some of the inter-atomic bonds will be stronger than others. If such a molecule can be caused to detonate by the action of a stream of electrons it is highly probable that the velocity of this electronic stream will be sufficiently high to cause the severance of even the strongest bonds. It might conceivably be the case, however, that by reducing the velocity of a stream of electrons a condition might be experienced in which only the weaker bonds would be broken, thereby splitting the molecule into parts differing from those which would result if the detonation of the molecule were complete. If bonds of several degrees of strength existed in a molecule it is conceivable that some of these bonds would be broken and others remain

(Continued on page 544.)

Birdseye View of the Fire-Swept Area of Old Hickory—Taken from the Roof of the Power Plant—Showing the Destroyed Solvent Recovery Area

The Old Hickory Fire

By

F. H. MILES, Jr.

POWDER, machinery and buildings valued at more than two million dollars were destroyed in a fire which swept through a forty-acre tract in the center of Old Hickory, the great Ordnance powder factory at Nashville, Tennessee, Sunday, August 10, 1924.

Approximately 50 million pounds of smokeless powder —which represented a large portion of the war reserve being retained by the Ordnance Department—were destroyed as also were about five hundred thousand dollars worth of powder manufacturing machinery and some 106 storage buildings. Thus was nearly totaly defaced one of the marvels of the Ordnance effort in the World War and possibly the greatest powder plant ever constructed.

One of the marvels of the war was the feat performed by the DuPont Engineering Company in building the Old Hickory Powder Plant. To take six thousand acres of Horse Shoe Bend on the Cumberland River near Nashville, Tennessee, and convert them into a powder plant capable of manufacturing a million pounds of smokeless powder a day could only have been performed by capacity for achievement well nigh superhuman. Not only were the powder and many of the required raw materials to be manufactured but the army of employees had to be housed, fed and amused. A visit to Old Hickory in 1918 at the height of activity there filled one with a great sense of pride in the American power to accomplish.

The war over, the great plant became impracticable for the purpose for which it was built, and a fair return on the Government's investment was all that could be expected. Through the use of the tremendous power plant, the hundreds of buildings, and the village complete in every modern essential, it was hoped that the development of Old Hickory as an industrial center would be effected. However, the greater part of the powder plant was built for special purposes; its arrangement and equipment, therefore, did not lend themselves to conversion to industrial activities.

Storage of War Reserve Powder

The problem of storing the large stocks of smokeless powder which had been manufactured, made the setting aside for this purpose of all suitable buildings at Old Hickory imperative, and when the plant was sold the United States reserved the right to retain its powder stocks in storage there until November, 1925. Upwards of a hundred million pounds of powder were placed in storage there, and the big problem of protecting the buildings from fire and intrusion and of watching the powder for evidences of deterioration commenced. From 1919 till 1924 no mishap of major importance happened in connection with the storage and surveillance of this powder, and perhaps none would have, had not certain circumstances combined to render ordinary precautions ineffective.

From 1919 to 1924, salvage operations on the buildings and power house have reduced the powder manufacturing plant to almost a complete state of ineffectiveness except for those buildings in which the United States stored its powder and some of its war reserve of powder manufacturing equipment. The hope for an industrial center had largely waned and the ultimate salvaging of the entire plant seemed probable. Recently, the DuPont interests have purchased the village and a tract of the land and are building on it a large modern factory of concrete and steel in which fibre silk is to be manufactured. As a result of this purchase, the village which had begun to show the signs of sleepiness and neglect is awakening, and repairs and paint are placing the neat little homes in first-class condition. Old Hickory really has a delightful location and it is reassuring to feel that at least a part of the war effort is to be placed directly into effective peace time use. That Old Hickory could thus be saved from the utter waste of salvaging is of real importance to us industrially as a nation. This nation has a vital lesson to learn in the conservation of raw materials, and the all too frequent American method of "scrap it, it does not exactly fill the bill" has received

at Old Hickory a definite setback.

The Conflagration

We have the picture then, on Sunday morning, August 10, 1924: The Old Hickory village coming to life, the permanent DuPont factory being erected on new ground, and the greater part of the war time powder factory not already salvaged used as a storage depot for a part of the Ordnance Department's war reserve of powder. Perhaps two-thirds of the salable parts of the powder plant had been salvaged.

Firewalls and Debris of Solvent Recovery Buildings

In order to visualize the fire, it is important to gain some conception of the area that burned. This may roughly be described as an area one and one-quarter miles long by one-half mile wide, very flat, and unbroken by trees or other heavy vegetation. The conflagration started in what was known as the solvent recovery buildings which were situated about midway in the short dimension of the plot burned and covered nearly the entire length of the long dimension. The fire spread from the solvent recoveries to one of the air-dry buildings on the west and to auxiliary buildings on the north and south, and, on the east, to the cutting, press and mixing houses in the manufacturing area which fed the solvent recoveries. It is hard to visualize the magnitude of this fire but a better idea may be obtained by saying that if you take a building seventy-five feet wide by four miles long and at intervals of about 250 feet place cross walls of brick, and then fill in between each of these sets of walls with 50,000,000 pounds of smokeless powder, you have in one line what actually was divided into four lines two hundred feet apart at Old Hickory. The distance from the most westerly line of solvent recoveries to the air-dry house which burned was 400 feet, and the distance from the most easterly line of solvent recoveries to the nearest building in the actual powder line was some 400 feet. A total of 106 buildings was burned and but 16 of these were actually solvent recovery buildings. The principal loss outside of solvent recoveries and actual powder manufacturing buildings and equipment was the refrigerating house and equipment which served the solvent recoveries and mixing houses.

The alarm for the fire was turned in by the guard in the solvent recovery area at 5:20 A. M. and he described the morning as cool with no wind and the time as well after dawn. The fire started in the extreme north end of the second line from the east of the solvent recoveries. It spread from compartment to compartment of the solvent recovery buildings, not through the brick fire walls, but by jumping the 200 feet between recoveries and attacking the board siddings which made up the outside walls of the recoveries between the brick fire walls. The roofs were of galvanized iron.

Close-up View of Former Solvent Recovery Buildings

Obstacles in Fighting Fire

The succession of mishaps which aided the spread of the fire began almost with the alarm, for the fire truck stalled on its way to the fire, and took from five minutes to three-quarters of an hour to go a halfmile, depending upon whose estimates you accept; the estimate of the Fire Chief being five minutes and that of the Police Chief three-quarters of an hour. There was probably a vital delay here of about one-half hour in getting water into action. It so happened that lines of hose were laid and put into action at about the time that the heat of the advancing fire became so intense that they had to be abandoned. Thus effective action was prevented in the early part of the fire. The facilities provided by the one fire company and the volunteers were hopelessly inadequate to combat a fire of this size. The fire zigzagged from compartment to compartment, each compartment fire consisting of the inflammation of the wooden exterior walls, followed by the subsequent ignition of the successive lots at small intervals, the intervals depending upon the type of powder container and the special manner of transmission for each compartment. The flare up of the powder lots projected huge volumes of flame and yellowish-black smoke straight up into the heavens and qualified spectators said thousands of feet alone described the heights of the smoke and flames from each compartment. The heat became so intense that the bare 400 feet between the solvent recoveries and the nearest buildings caused many of them to take fire, and as many of these had powder stored in them the situation was precarious. Good work was done on these buildings up until about 8 o'clock, when the poles for the electric power lines supplying the fire pumps began to burn. The steam fire pump upon being started was jammed. Fifteen minutes later the electric power failed. Then there was an interval of perhaps an hour when there was no pressure in the fire mains.

The steam-driven fire pump was put back in action at about 9 o'clock but in the interval the fire had spread to the powder manufacturing buildings. Every alternate building contained powder. It was only after the intense heat had died down in the solvent recovery areas that the fire could be handled in the other areas. At 5 o'clock the fire was under control.

Remains of Mixing House Where Powder and Machinery Were Stored

There was practically no wind at all on the day of the fire. Had there been undoubtedly the entire plant, storage area, and village would have burned. What wind there was was from the northwest and even this slight drift caused small particles of metal from the powder containers held aloft by the upward rush of hot air to be carried as far as two miles.

Another fortunate circumstance was the greenness of the grass and other foliage which withstood the heat and flames in a remarkably effective manner.

Tremendous Loss

The total loss of powder was in the vicinity of 50,000,000 pounds. It is estimated that this liberated heat enough to evaporate nearly 100,000,000 pounds of water at 212° F. Thus it is seen that fabulous amounts of heat were liberated. How quickly this tremendous heat was dissipated is shown by the fact that fire fighters were able to operate at times within 800 to 1,000 feet of the center of the fire without scorching. The only man burned was the guard who turned in the alarm and who went too close to the building in which the fire originated in the first minutes of the blaze. He was caught by one of the first blasts of flame about one hundred and fifty feet from the building. He was burned on the forearm and neck but not seriously.

The cause of the fire was difficult to fix because of the destruction of the evidence in the fire itself. Previous experience and the circumstances of the fire as far as they are known indicate spontaneous combustion of deteriorated powder as the most probable cause.

When the data on amounts of explosives and the distance between buildings have been thoroughly compiled much information of value for the future construction of powder plants and powder storage areas should be available.

Perhaps the most fortunate thing about the fire was the fact that the village was not burned, for it and the new factory, unburned by the fire, form a real nucleus for the industrial development of "Old Hickory."

View of Horizontal Line of Press Houses Where Powder Was Stored

Some figures concerning the gigantic undertaking involved in the development of Old Hickory, as published in the *Nashville Tennessean*, August 11, 1924, may be of interest:

Building of the Old Hickory Powder Plant was the largest project of its kind ever attempted. The plans called for erection of a factory capable of producing 900,000 pounds of smokeless powder every 24 hours, the plant to be divided into nine complete units of 100,000 pounds daily capacity each.

The site, which since the war has been converted into a thriving industrial city, is at Hadley's Bend, about twelve miles from Nashville.

When work was commenced on the plant, there were no transportation facilities to the site; there were no housing accommodations for the workmen or their families. Materials had to be brought to the site, railroads built, bridges constructed; houses, barracks and hotels erected; in short, it was necessary to transport and erect everything needed for the job and for the comfort and convenience of the thousands who began work. At the height of the war work nearly 40,000 persons were employed.

The site comprises 1,800 acres. There are:
Over 200 factory buildings,
Fifty-four miles of broad-gauge railroad track,
Forty-four miles of narrow-gauge railroad track,
Nineteen miles of concrete and macadam roads,
Twenty-five miles of cinder roads,
Thirty-three miles of board walks,
Sixty-one miles of tile drains and sewers,
Forty-five miles of water lines,
One hundred eighteen miles primary power lines,
Seventy-eight miles of secondary power lines,
Forty-six miles lighting circuits,
Twenty miles fire alarm circuits,
Three locomotive cranes,
Three broad-gauge locomotives,
Two narrow-gauge locomotives,

Pumping capacity of the water supply, 100,000,000 gallons per day, in connection with which there is filtering capacity, 65,000,000 gallons daily.

Storage capacity: Raw water, 4,000,000 gallons; filtered water, 15,000,000 gallons; normal water pressure, 135 pounds.

The water plant is of sufficient size to supply a city of 750,000 persons.

Accuracy Firing

By

PHILIP SCHWARTZ

ONE gun is more accurate than another, if when fired: *a*, from same mount; *b*, by same gun crew; *c*, at same time or under same weather conditions; *d*, using same type and lot of ammunition; *e*, using same angles of elevation, one has a smaller dispersion in altitude, range, and deflection, at all battle ranges, than the other. Likewise, one type of projectile is more accurate than another if its dispersion is less when fired from the same gun and under conditions *a*, *b*, *c*, and *e*, above.

Under standard atmospheric conditions, after a projectile has left the bore of a gun, it can be assumed that only three distinct factors enter into the determination of its point of impact. They are muzzle velocity (V), angle of departure (ϕ), and ballistic coefficient (C). V and C depend upon the powder charge, projectile, and design of the bore of the gun. Variations in these three factors only, can cause variations in the position of the point of impact of the projectile, and the effect of a variation in one of these factors depends on the values of the other two. Any dispersion or improvement in range can be traced back to a variation in either V, ϕ, or C.

Ordinarily a particular combination of gun, powder charge, and projectile, is fired at a constant muzzle velocity, and with an almost constant ballistic coefficient, but with widely varying angles of departure. The firing table consists essentially of a table whose independent variable is angle of departure and whose dependent variables are the characteristics of the trajectory (projectile, powder charge, and gun, being the same throughout). As the value of ϕ increases from small to large values, there is a very large change in the effect on the trajectory of the small errors which may occur in V, ϕ, and C. The table below shows how the range is affected by small changes in V, ϕ and C for varying values of ϕ and for different guns.

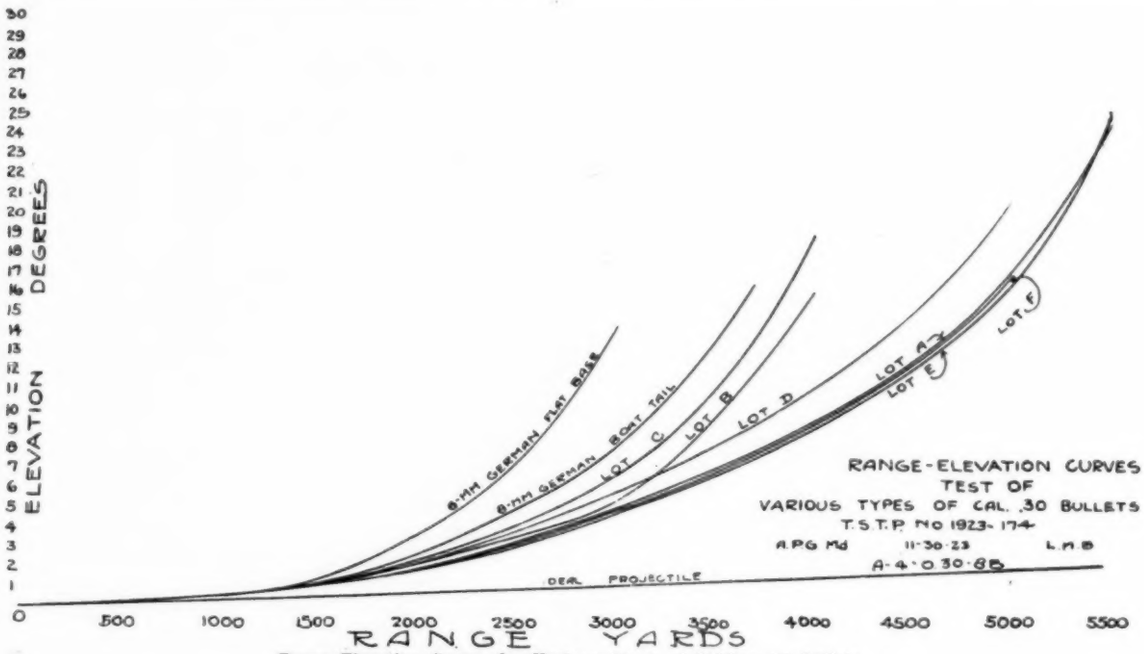
An examination of this table shows that at short ranges and corresponding low values of ϕ, the effect of a small change in ϕ is much greater than that due to a small change in V or C. It is therefore probable that any dispersion in range which occurs at very short ranges is due to slight changes in ϕ from round to round, because of errors in quadrant or sight setting and because of variations in jump of gun from round to round. On the other hand, at long ranges and with corresponding high ϕ's it can be seen that the effect of a slight change in ϕ becomes negligible, and that changes in V or C from round to round probably cause most of the dispersion in range.

To test the stability of a gun mount, firing at short ranges is correct, in order to permit the dispersion in ϕ alone to enter into the results. *To test the ranging properties of any change in design of projectile, bore of gun, or powder charge, firing at long range is correct.* The longer the range the greater is the effect of changes in V and C. The effect of a change in design of projectile is strikingly illustrated by the graph on the following page.

From the graph it can be seen that for these projectiles, all of which had about the same muzzle velocity, a poor projectile ranged about as well as a good one up to about 1500 yards. It was only at longer ranges and corresponding higher ϕ's that the comparative ranging power of the projectiles become truly evident. For the purpose of deciding on the type of projectile which will give the greatest range for a particular V and ϕ, firings at low values of ϕ will give little positive information, whereas at higher ϕ's and longer ranges, the better projectiles will show up clearly. A projectile which is appreciably better than another at long ranges is practically always better at short ranges. A projectile which is found by firing to be better than another at short ranges will not necessarily be better at long ranges. This is due to the fact that there is a possibility that errors in ϕ, due to the gun itself rather than the projectile, have entered into the measured result at short ranges, and also because of the greater accuracy of measurement required to expose differences in ranging qualities at short ranges.

The graph can also be interpreted to show that at low angles of elevation variations in the shape of the projectile—that is, in the ballistic coefficient—will cause little dispersion in range, but at higher elevations the dispersion will easily be detected by the more appreciable difference in range.

Caliber	Velocity f.s.	Weight of Projectile	Range (R) yards	Angle of Departure ϕ	Change in Range for change of 1′ in ϕ yds.	10 f.s. in V yds.	1 Per Cent in C yds.
30 Rifle	2700	155 gr.	1,000 In.	1′	42	.5	.1
			100 Yds.	3′	39	1.0	.5
			600	20′	19	3.4	2.7
			1,000	49′	10	4.2	4.6
			2,000	3° .54′	3.3	4.6	10.1
			3,000	13° .05′	1.0	4.4	18.1
			3,400	24° .30′	.3	4.1	22.9
75-mm. Gun	1955	13.5 lbs.	1,000	.50′	18	10	1
			5,000	6° .50′	8	31	18
			12,700	41° .15′	1	43	63
155 mm Gun	2410	95 lbs.	1,000	.33′	32	7	3
			5,000	3° .34′	17	30	18
			17,400	35° .11′	3	63	91
8-inch Gun	2600	200 lbs.	1,000	.27′	36	7	1
			5,000	2° .50′	22	30	12
			21,300	42° .05′	1	77	113
14-inch Gun	2400	1400 lbs.	1,000	.24′	33	8	1
			5,000	2° .39′	27	38	4
			23,000	20° .35′	10	139	85



Range Elevation Curves for Various Types of Caliber .30 Bullets

It is often desired to determine when a gun has become worn or eroded to such an extent that projectiles fired from it do not have sufficient uniformity in their points of impact. In such a case the same conclusions concerning the best range for the detection of this condition may be drawn as were drawn with regard to changes in the design of projectiles. An eroded gun causes a reduction in muzzle velocity and in ballistic coefficient, and also affects the uniformity of these two quantities. It is believed that the dispersion in muzzle velocity is not so much different in an old gun from that in a new gun, as is the dispersion in ballistic coefficient. The dispersion in ballistic coefficient is due principally to ragged and non-uniform engraving of rotating band, and to loss of rotational velocity which causes instability in flight. However, whether the range dispersion be due to dispersion in V or in C, it can be seen from the table that it is only at longer ranges that dispersion in V and in C has such an effect on range that it can easily be measured.

In testing of small arms it is the custom to make most of the measurements at relatively short ranges, because the battle range is so short. For instance, Item 3675 of the Ordnance Committee Minutes deals with reported trouble in determining when the bore of a rifle has been worn out. The recommendation adopted was that a firing test "will consist of three targets of 10 shots at a range of 300 yards," this being considered to be the "most suitable range by reason of the fact that it is short enough so the firing is not appreciably affected by weather conditions and yet long enough to give a reliable measurement of the group." This procedure eliminates the part of the test which was formerly made at 500 yards and puts the whole test at 300 yards range. It appears to be a change in the wrong direction, for even 500 yards is too short to give an accurate measurement of the condition of the bore.

It is true that weather conditions may affect the results of long range firing more than those of short range firing. However, if an erosion test is to be of any value, it should be comparative. Groups should be fired alternately from the worn gun and from a gun which is known to give satisfactory accuracy.

The arguments brought out in this discussion against accuracy firing at short ranges, apply with added force to the case where the rifle is not set in a mechanical rest, but is subject to the variations in angle of elevation from round to round, which even an expert rifleman must cause. The effect of a variation of a minute or two in elevation at short ranges is to overwhelm any dispersion due to variations in V or C, these latter being the quantities which are really being investigated in such an erosion test. If it is found at short ranges that the projectiles are "keyholing" the erosion test has accomplished little, for such a condition may be observed during ordinary target practice.

In small arms testing, most of the firing is against the vertical targets which are convenient for short ranges. The previous discussion has treated of firing against horizontal targets. However, the theory of vertical dispersion is exactly the same as that of horizontal dispersion. A satisfactory small arms range should have equal facilities for long range as well as for short range firing. It is not believed that there should be any more practical difficulty in getting satisfactory measurements at long ranges than at short ranges, because of the fact that measurements need not be made so accurately at long ranges in order to expose any particular condition of affairs by comparative firings.

Erosion tests should be made at the longest range practicable, preferably by firing from a mechanical rest. If the argument is made that a rifle is not fired at long ranges either in battle or in practice (although machine guns frequently fire at long ranges) the answer is that it is impossible to measure the accuracy of a gun or projectile satisfactorily at short ranges. A gun which is better than another at long ranges is generally better at short ranges. The point to be stressed is that comparative measurements at short ranges are difficult to make accurately, and that the dispersion which is obtained at these ranges may be caused mainly by a factor which should not enter into the test.

German High Explosives in the World War

By

G. C. HALE

THE principal explosives used by the Germans during the World War are very generally known. The substitute explosives to which they turned as the demands of the War increased, are perhaps not of such general information. Investigation of captured German ammunition has revealed that a wide variety of explosive materials were brought into use and has suggested the extreme effort on the part of the Germans to meet the almost insatiable demand for artillery ammunition. The fact that many of these explosive substitutes were much inferior to the standard explosives in use by the various nations at the outbreak of the war is of much interest and tends somewhat toward belated amusement when one recalls the speculation, rife during the War, as to whether the Germans would be able to devise some explosive far more destructive than any previously known. It is apparent that the explosive problem of the Germans was not so much the invention of some new and "more powerful" explosive, but rather the utilization of their available raw materials to produce something in the way of explosives that could be used as a charge for ammunition components. It cannot be denied that they were quite successful in solving this urgent problem.

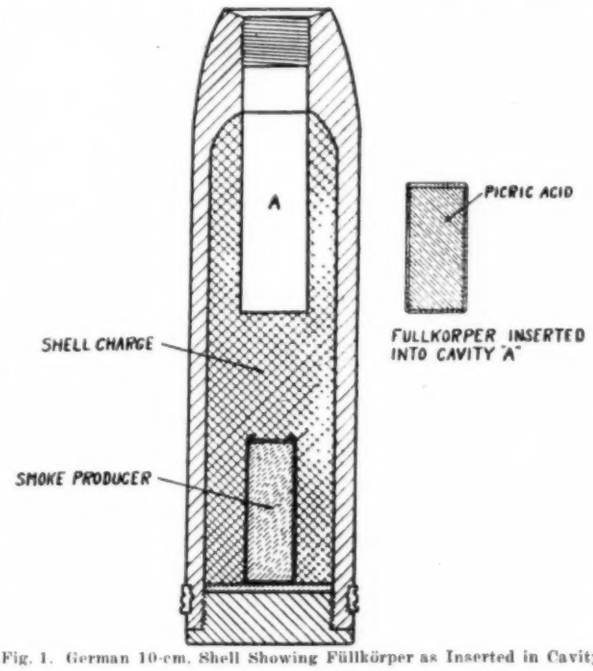


Fig. 1. German 10-cm. Shell Showing Füllkörper as Inserted in Cavity

In the following brief discussion of the principal high explosives and substitutes used by the Germans, it is intended to indicate to a certain extent, the complexity of their problem with regard to high explosives.

Picric Acid

This explosive having the designation "*Granatfuellung* 1888" (Grf. 88) was adopted as the standard filler for high explosive shell in 1888 but was superseded in 1902 by TNT. Picric Acid however was used to some extent during the War as a filler for 10-cm. and 15-cm. shell but its main use was as a booster charge. Nearly all German fuzes were combination fuzes and boosters, the latter containing picric acid as the detonating charge.

Another method of using picric acid as a booster consisted in placing a cylindrical paper carton filled with the pressed material in a central cavity drilled into the main body of the shell charge. This so called "füllkörper" insured the complete detonation of the shell charge, and at the same time reduced the amount of explosive necessary for the fuze. Fig. 1, made from an original drawing, shows a "füllkörper" and its position in the charge.

TNT

This explosive, under the caption "Füllpulver 1902" (Fp. 02), was used very widely as a shell filler having been loaded by casting into shell of practically all calibers. In many cases it formed only the upper portion of the charge, while the lower part consisted of some comparatively insensitive explosive which required a strong initiation to bring about its complete detonation e. g. dinitrobenzene, lonarit, trinal, etc. The Germans had no other explosive as generally satisfactory to them both as to brisance and sensitivity as TNT.

There were two mixtures of TNT and ammonium nitrate used, the one containing 60 per cent TNT and 40 per cent nitrate, the other 55 per cent TNT and 45 per cent ammonium nitrate. These were designated Fp. 60/40 and Fp. 55/45, respectively. Both mixtures could be loaded by casting. As a rule when Fp. 60/40 was used with shell below 17-cm. in caliber a smoke producer, *"Rauchentwickler,"* was introduced into the charge. These smoke producing bodies were cylindrical pasteboard cartons filled with the smoke mixture. They were placed in the base of the charge as shown in Fig. 1. There were two smoke mixtures used, one containing phosphorus and paraffin, the other phosphorus, arsenic and paraffin.

Trinitroanisole

The practical impossibility of producing sufficient TNT demanded that new explosives be developed for use as shell fillers. Trinitroanisole is said not to have been tested as a practical military explosive before the war, but its properties were only recorded in the literature. The use of trinitroanisole under the designation

"An" was authorized in December, 1914, and within a few months it was being loaded into 9, 10, 12, 15 and 21-cm. shell. Considering the short time which had elapsed after the beginning of the War until trinitroanisole was introduced, it appears more likely that it had been investigated before the War and its introduction awaited only the demand for its use. In nearly all these calibers of shell it was substituted for TNT and was used as the upper or cover charge. The explosive power of An. was said to be somewhat greater than TNT but it was also more sensitive, which was considered as an objection.

The physiological action of trinitroanisole on workmen greatly hindered the use of this explosive and, in fact, finally caused it to be abolished except for shell of large caliber, mines, and bombs, all of which could be loaded by less contact of the workmen with the explosives. When first used trinitroanisole was poured directly into shell of small caliber, 10-cm., 15-cm., etc., but so much sickness in the filling plants led to the method of loading the explosive in cartons and then only for large calibers. In this way the number of castings was greatly decreased at the filling plants for a given amount of material used. As the charges were always cleaned before being sent to the assembly depots, the actual loading of the shell was accomplished without injury to the workmen. The Leverkusen Dye Works, where a great part of the trinitroanisole was made, established the following rule for the protection of the workmen:

"The work must be done in the open air if possible, if not, air must be conducted through the building by a special arrangement. Before beginning the day's work the ground must be sprinkled with water and the entire work place arranged in the best of order. The workmen must wear gloves reaching to their elbows and be furnished with special washable working costumes which must be washed weekly. Before beginning work the face, neck and hands must be powdered with magnesium oxide. After finishing work for the day and at each rest period the face and hands must be washed with water without using soap."

A mixture of 60 per cent trinitroanisole and 40 per cent ammonium nitrate under the designation An. 60/40 was authorized in August, 1916, for loading 21-cm. shell. Numerous prematures with these shells, although supposed to be due to faulty loading, led to the withdrawal of An. 60/40 from the service in July, 1917.

Dinitrobenzene

Prior to the War this material had not been used as an explosive but as the demand for additional explosives increased the Germans found that by using dinitrobenzene as the lower portion and an upper portion of TNT or trinitroanisole an efficient bursting charge could be produced. This method of using dinitrobenzene was inaugurated in December, 1914, and shortly after shell from 10-cm. to 24-cm. were being loaded with dinitrobenzene as a portion of the charge. Experiments were carried out later to ascertain if a mixture of 60 per cent TNT and 40 per cent ammonium nitrate (Fp. 60/40) would also successfully detonate dinitrobenzene, when the latter was used as the lower portion of the shell charge. Results were favorable and in September, 1915, the use of Fp. 60/40 was authorized as an upper portion for certain shell in which dinitrobenzene was used as the main charge. In case of base-fuzed shell, of course the position of the respective portions of the shell charge were reversed, i. e., TNT, trinitroanisole, or Fp. 60/40 became the lower portion and dinitrobenzene the upper portion.

Much sickness was caused among workmen in the filling plants where dinitrobenzene was used, in spite of precautions taken, and after November, 1916, all dinitrobenzene loaded into large shell was first loaded into paper cartons since with this method the workmen were less exposed.

A mixture of 65 per cent dinitrobenzene and 35 per cent ammonium nitrate was also used as a shell filler. When small shell, 15-cm. or less, were loaded with it a "füllkörper" or booster of picric acid was inserted under the fuze in a cavity drilled or formed into the charge, so that complete detonation was insured. It was claimed that the dinitrobenzene-ammonium nitrate mixture had a higher brisance than dinitrobenzene alone.

Donarit and Westfalit

The use of these explosives as lower portions of the charges of 10, 12, 13, 15 and 21-cm.-shell was authorized during the latter part of 1914 and the early part of 1915. Each of the explosives originally contained about 4 per cent of nitroglycerine, but in June, 1915, the use of nitroglycerin in the composition was discontinued; thereafter the constituents of these explosives were as follows:

Westfalit:

77 parts Ammonium nitrate,
15.2 " TNT,
3.8 " Meal.

Donarit:

77 parts Ammonium nitrate,
15.2 " liquid TNT,
3.8 " Meal.

"Sprengstoff 41"

The mixture consisted of:

48 parts TNT,
12 " Dinal (Dinitronaphthalene),
40 " Ammonium Nitrate.

The use of the Dinitronaphthalene was simply for the purpose of saving 12 parts of TNT in the regular 60/40 TNT-ammonium nitrate explosive.

"Sprengstoff 30"

At practically the same time as the preceding explosive was introduced, another substitute was devised to effect a further saving of TNT. The constituents of this explosive were as follows:

37 parts TNT,
18 " Trinol (Trinitronaphthalene),
45 " Ammonium Nitrate.

"Sprengstoff 16"

This explosive was used especially in shell for the field howitzers. It consisted of:

20 parts TNT,
10 " Sodium Nitrate,
5 " Dicyandiamide,
65 " Ammonium Nitrate.

The shell with this charge contained 2 füllkörpers when no smoke producer was used. All others contained one füllkörper and one phosphorous-arsenic smoke producer.

In connection with this composition it was claimed that certain organic compounds as dicyandiamide, sodium acetate, and anilin oxalate when added to ammonium nitrate, together with about 10 per cent sodium nitrate, would lower the melting point of the ammonium nitrate to such an extent that the mixture could be cast at about 100° C., thereby making it possible to use a liquid explosive with high ammonium nitrate content.

Ammonal

There were two mixtures used under this name. The constituents of each were as follows:

(1)	TNT	12 Per Cent,
	Ammonium nitrate	72 Per Cent,
	Aluminum	16 Per Cent,
(2)	TNT	20 Per Cent,
	Ammonium nitrate	70 Per Cent,
	Aluminum	10 Per Cent.

Perchlorate Explosives

Although 28,000,000 pounds of ammonium nitrate are said to have been produced monthly in Germany, it was insufficient and it became necessary to make use of perchlorate explosives to some extent. By mixing ammonium perchlorate with about 45 per cent nitro-bodies, which consisted of a mixture of dinitronaphthalene and dinitrobenzene, a liquid explosive was produced that was used in certain mines and hand grenades and for demolition purposes by the engineers. A central booster was always used with the mixture as its detonation was brought about with some difficulty. Perdit, an explosive used for demolition, contained potassium perchlorate, ammonium nitrate and TNT.

Liquid Air

An explosive styled *"Flüssigluft"* (liquid air) was used extensively for demolition purposes by Engineer troops during the latter part of the War. The work with this explosive was done by a special company of the engineers, called the *Flüssigluft Kompagnie*, skilled or experienced men being required for the work.

The explosive consisted of cork meal or soot, as carbon carriers, saturated with the so-called liquid air. This liquid consisted of about 95 per cent oxygen and 5 per cent nitrogen. The liquid was shipped to points near the front in vacuum jacketed containers having about 15 liters capacity. The evaporation of the liquid was rapid, the container being completely emptied by evaporation in about 15 days if allowed to stand.

The cork meal or soot was pressed into paper cartridges and shipped in this fashion. In using the explosive the cartridge was dipped into the liquid air and was slowly but completely saturated. A special dipping vessel of metal, glass or porcelain was used for the purpose. The explosive was detonated either by means of a black powder fuze or electrically. The usual blasting cap partially loaded with TNT could not be used if it was exposed to the low temperature of the liquid air for any length of time. By using a special covering or coating for the lasting cap as a protection, the cap could be used as a detonator. It is claimed that the brisance of this explosive is equal to that of picric acid, but that it can not be used as a shell filler owing to the influence of the low temperature on the physical properties of the metal of the shell.

In addition to the explosives mentioned above, a mixture of TNT and hexanitrodipheylamine in equal proportions by weight, was used as a filler for torpedoes. The 50-cm. torpedoes had a charge of about 200 kgs. and the 60-cm. torpedoes a charge of 250 kgs. of this explosive. Its action was supposed to exceed that of wet gun cotton by about 30 per cent.

Hexanitrodiphenyl-sulphide, or picryl sulphide, in admixture with TNT was also used as a filler for bombs. The starting materials for the production of the sulphide were trinitrochlorbenzene and sodium thiosulphate, both of which were available in considerable amount.

Among all the above explosives there were five constituents that had never been used previously as military explosives, viz: trinitroanisole, dinitrobenzene, hexanitrodiphenylamine, hexanitrodiphenylsulphide and "liquid air." No one of the first four explosive compounds mentioned offers any advantages over TNT from the standpoint of efficiency as a filler for shell or bombs, while each one has some objectionable features which render it inferior to TNT from the general standpoint of usage. The last mentioned explosive, liquid air, was merely a substitute used for blasting purposes. Hence, the conclusion that the principal contribution of the Germans in the field of explosives was the development of a wide variety of substitutes, rather than the invention of any explosive more efficient, for its purpose, than was previously known.

The Future Value of Shrapnel

Apropos of the changing methods of warfare, Col. J. Edward Cassidy, in a recent official publication, made the following pertinent comment:

"The lessons of the World War must not be forgotten, but we must bear in mind the fact that the next war will be radically different and fought under entirely different conditions, no matter where it may be. The nation that succeeds in warfare must not live in the past but look ahead. It took the people of Great Britain more than a year to 'get the idea out of their systems' that the World War was merely the Peninsular War, the Crimean War or South African War on a larger scale. Their training and theories were based entirely on what has been done in the past, and Lord Kitchener was one of the hardest men to convince that a new era in warfare had dawned. It was not until after the Battle of Loos and Hill 70 that the British accepted the fact that the day of shrapnel had passed in favor of immense quantities of high explosives.

"However, we must not assume that shrapnel will be so much in the minority in the next war as in the World War, for this is an extremely useful article in a war of movement. While immense quantities of high explosives will be used, yet we may expect to find practically as much shrapnel, and gas on a scale never dreamed of in the World War.

"In order that we may be prepared for eventualities, we must erase from our minds the picture we so easily construct of fighting the next war in a country such as France, where there is a maze of high class roads at every turn, and of basing our studies on a war of positions, for it is certain that when we engage in war, if we ever do, it will be a war of movement, with the lines of communication much longer and much more difficult."

New Constitution and By-Laws

of the

Army Ordnance Association

The following Constitution and By-Laws of the Association were adopted by letter ballot of the entire voting membership, June 30, 1924, on which date the polls closed. 620 ballots were received of which 19 were disqualified for the following reasons: 4 were received after the polls closed, 11 were received without means of identifying the sender, and 4 ballots were not marked Of the 601 valid votes cast 598 were in favor of adoption and 3 were opposed.

CONSTITUTION

Article I
NAME

The name of the organization shall be the ARMY ORDNANCE ASSOCIATION of the United States of America.

Article II
OBJECTIVES

The objectives of the Army Ordnance Association shall be:

To assist in effecting industrial preparedness for war as being one of the Nation's strongest guarantees of peace;

To keep available the highly specialized knowledge necessary for arming the manhood of the nation by stimulating interest in the design and production of ordnance material;

To promote mutual understanding and to effect cooperation with American Scientists, Inventors, Engineers and Manufacturers in civil life and the Regular and Reserve Officers of the Army Ordnance Department;

To provide, when required, the services of competent committees to investigate and report upon special ordnance subjects;

To assist in developing and maintaining an efficient personnel, both commissioned and enlisted, for the units required for Ordnance Field Service in the event of an emergency;

To commemorate the services rendered by the Industry of the Nation and by the Officers and Civilian Employees of the Ordnance Department in the wars in which the United States has been engaged.

Article III
MEMBERSHIP

Sec. 1. Full membership in the Army Ordnance Association shall be open to all men who are American citizens and who are interested in promoting the cause of industrial preparedness, particularly in connection with the design, procurement, production, manufacture, inspection, test or supply of Ordnance material.

Sec. 2. Junior membership in the Army Ordnance Association shall be open to all men who are American citizens and who are students in Technical Schools or Colleges in which Ordnance units of the Officers' Reserve Corps are maintained. Junior members shall not vote nor hold office in the Army Ordnance Association.

The term "member" when hereinafter used, and when used in the By-Laws of the Association, shall refer to full members only.

Nothing in this Section shall be construed to change the existing status of any junior or associate members, but all new members received into the national Association, or any Post thereof, shall conform to the classifications above defined.

Article IV
OFFICERS

The officers of the Army Ordnance Association shall be a President, two Vice-Presidents, a Counsel, a Secretary and a Treasurer.

Article V
THE BOARD OF DIRECTORS

Sec. 1. The general conduct of the affairs of the Army Ordnance Association under the authority and limitations of this Constitution, shall be vested in a Board of Directors.

Sec. 2. The Board of Directors shall consist of the President, who shall be ex-officio chairman, the Vice-Presidents, one Director elected by each duly authorized Post of the Association, and six Directors elected by general ballot of the members of the Association.

Sec. 3. The Board of Directors shall prepare By-Laws governing the Association which shall become effective when approved by a majority thereof by letter ballot.

Sec. 4. The Board of Directors shall have power to fill casual vacancies, by appointment for the unexpired terms thereof, in the offices of President, Vice-President and in the roster of Directors elected by general ballot. Casual vacancies occurring in the roster of Directors elected by local Posts shall be filled by the Posts concerned in accordance with their respective Constitutions and By-Laws.

Article VI
LOCAL POSTS

Sec. 1. Local Posts of the Army Ordnance Association may be formed under such regulations as may be prescribed from time to time by the Board of Directors.

Sec. 2. The organization of the Army Ordnance Association proper as distinguished from its local posts is hereinafter referred to as the "national association."

Article VII

ELECTIONS AND APPOINTMENTS

The President, Vice-Presidents and six Directors shall be elected by letter ballot of the entire active membership and shall hold office: the President and the Vice-Presidents for two years and the Directors for four years, the term of one-half terminating on December 31, 1924, and alternating every two years thereafter.

The method of election and terms of office of Directors representing local posts shall be determined by the respective posts. The fact of election and term of office of each Director elected by a local post shall be certified to the National Association by the President and Secretary of the local post.

The Treasurer, Counsel and Secretary shall be appointed by the Board of Directors for a term of two years.

Article VIII

MEMBERSHIP DUES

The annual dues for membership in the Army Ordnance Association shall be, for Members, Five Dollars ($5.00), and for Junior Members, Two Dollars and Twenty-five Cents ($2.25) per year, payable in advance. These sums are in addition to whatever dues or assessments may be imposed by the respective local posts in the case of members.

Article IX

ANNUAL MEETING

The annual meeting of the Association shall be held in the autumn of each year, preferably during October, for the discussion of new and improved methods of manufacture, for the demonstration of such experimental types of ordnance matériel as may be authorized by the War Department, and for other purposes.

Article X

AMENDMENTS

Sec. 1. Amendments to this Constitution may be proposed by a majority vote of the Board of Directors or upon petition addressed to the President and signed by not less than fifteen members.

Sec. 2. Proposed amendments shall be submitted to the entire active membership by letter ballot and shall be adopted if a majority of votes cast are in favor thereof.

BY-LAWS

Calendar

1. The fiscal year shall close on December 31st of each year.

2. The yearly calendar shall be as nearly as practicable as follows:

June 1 (on or before), Nominating Committee of five members appointed by the President.

July 15 (on or before), Nominating Committee submits report of nominees to Secretary.

July 31 (on or before), Secretary sends out letter ballots for officers.

July 31 (on or before), President appoints three tellers of election.

September (first Tuesday), polls close at noon.

September 15 (on or before), tellers certify results of election to Secretary, who notifies President and newly elected officers and Directors.

Autumn (usually first Friday in October), annual meeting.

Decorations—Membership

3. Members of the Association have been authorized by the War Department to wear the decoration of the Association when in uniform on occasions which permit or require the wearing of other military decorations, and to wear the corresponding bar with the uniform on other occasions. They are also authorized to wear the corresponding button when in civilian clothes. Decorations, brass and buttons may be purchased from the Secretary of the Association at the cost price.

Subscription to Army Ordnance

4. Three Dollars ($3.00) of the membership dues of each member and Two Dollars and Twenty-five Cents ($2.25) of the membership dues of each junior member shall be applied to an annual subscription to the official journal of the Association—ARMY ORDNANCE.

Duties of Officers

5. The President, Vice-Presidents, Counsel, Treasurer, and Secretary shall perform the duties legally or customarily attaching to their respective offices under the laws of the United States and of the District of Columbia and such other duties as may be required of them by the Board of Directors.

6. The Secretary of the Association shall be ex-officio Secretary of the Board of Directors.

The Board of Directors

7. Four or more Directors shall constitute a quorum for the transaction of business. In the absence of a quorum, the Board may proceed to business, the proceedings in such cases becoming effective only after being submitted by the Secretary to the absent members and receiving the approval of a number which, with those present at the meeting, shall constitute a majority of the whole Board. In such cases the date of approval shall be the date of receipt by the Secretary of the last of the minimum number of approvals required to make the proceedings effective.

8. Meetings of the Board of Directors shall be called at the discretion of the President or by vote of the Board.

9. The Secretary shall notify each Director by mail of the date and place of each meeting of the Board of Directors not less than ten (10) days in advance of the meeting.

Nominations

10. A nominating Committee of five (5) members shall be appointed by the President on or before June 1st of each year. This Committee shall deliver to the Secretary in writing on or before July 1st, the names of its nominees for the elective offices next falling vacant in the Association. The Secretary will communicate with each nominee. In the case of the declination of any nominee to accept his nomination, the Secretary shall report the fact of such declination to the Nominating Committee, which will then nominate another member for the office.

11. Nominations may also be made by petition signed by not less than 5 per cent of the entire membership of the Association, which petition must be filed with the

Secretary together with the written acceptances of the nominations by the nominees, prior to July 20th.

Elections

12. The Secretary shall mail, on or before July 31st of each year, to each member entitled to vote a ballot stating the names of the candidates for the several offices falling vacant, and the time of the closure of the voting. The voter shall prepare his ballot by crossing out the name of any candidate or candidates rejected by him, and may write in the name of any eligible member of the Association. The voter shall enclose ballot in an envelope and seal the same. He shall then enclose the sealed envelope in a second envelope marked "Ballot for Officers," seal the same, and shall then write his name thereon for identification. The ballot thus prepared and enclosed shall be mailed or delivered unopened to the Secretary of the Association.

Tellers

13. The President shall, on or before July 31st of each year, appoint three tellers of Election of Officers, whose duty shall be to canvass the votes cast and certify the same to the President or Presiding Officer at the first subsequent session of the Board of Directors. The term of office of the tellers shall expire when their report of the canvass has been presented and accepted.

14. The Secretary shall certify to the competency and signature of all voters, and shall deliver, unopened, all ballots to the tellers of election. Ballots without the autographic endorsement of the voter written on the outside envelope are defective. Ballots which contain more names than there are offices to be filled are thereby defective, and shall be rejected by the tellers of election.

15. The voting for the election of officers shall close at 12 noon on the first Tuesday in September in each year. The tellers shall not receive any ballot after the stated time for the closing of the voting. The tellers of election shall first open and destroy the outer envelopes and shall then open the inner ones, canvass the ballots and certify the result to the President or presiding officer at the next succeeding session of the Board of Directors or presiding officer at the next succeeding session of the Board of Directors of the Association. The President or presiding officer shall then announce the candidates having the greatest number of votes for their respective offices and declare them elected for the ensuing year.

16. The names of the candidates proposed by the nominating committee or committees, and the respective offices for which they are candidates shall be printed in separate lists on the same ballot sheet.

17. In case of a tie in the vote for any officer, the President, or, in his absence, the presiding officer of the Board of Directors, shall cast the deciding vote.

Meetings

18. The Annual Meeting shall be held at the Aberdeen Proving Ground, Maryland, preferably on the first Friday in October.

19. Special Meetings of the Associaiton may be called at any time at the discretion of the Board of Directors, or shall be called by the President upon the written request of fifty (50) persons entitled to vote, the notices for such meetings to state the business for which such meeting is called and no other business shall be entertained or transacted at that meeting.

20. A notice of each Annual or Special Meeting shall be mailed by the Secretary to each member not less than thirty (30) days before the date of that meeting.

Local Posts

21. Upon petition signed by not less than twenty-five (25) members of the Army Ordnance Association in any locality stating their desire to form a local post and pledging themselves to subscribe Two Dollars ($2.00) each toward the expenses of organizing such post, the Secretary of the Army Ordnance Association shall immediately authorize a meeting for such inauguration and the Army Ordnance Association shall contribute to the organizing expenses of such post the sum of Two Dollars ($2.00) for each such petitioner, such payment to be, however, not over One Hundred Dollars ($100.00) in the aggregate for any one city.

22. When not less than twenty-five (25) members of the Army Ordnance Association shall have enrolled as members of such a post, the Army Ordnance Association shall issue a suitable charter thereto, signed by the President and Secretary of the Association.

23. Local posts shall be authorized to receive joint members into the Army Ordnance Association and local post upon signed application blank for such joint membership containing the same pledge and statement of objective as contained in Army Ordnance Association application blank. The local post shall collect annually whatever local dues may be assessed against its members, if any, plus Five Dollars ($5.00) annual dues to the national Association. It shall transmit Four Dollars and Fifty Cents ($4.50) of each Five Dollars ($5.00) annual dues to the national Association so collected, retaining the sum of Fifty Cents (50c) to cover the clerical work involved.

24. The constitution of each local post shall be submitted to the President of the Army Ordnance Association and approved by him before the same shall become effective.

Amendments to the Constitution

25. Proposed amendments to the Constitution shall be submitted by letter ballot to the members of the Association within thirty (30) days of their proposal.

26. Voting shall cease and the polls close on amendments to the Constitution thirty (30) days after the ballots have been mailed to the members. The votes shall be counted by a committee of three tellers, appointed by the President, and certified to the Secretary within fifteen (15) days after the polls have closed.

27. The results of such elections shall be announced in the next issue of ARMY ORDNANCE. Amendments shall become effective upon receipt by the Secretary of a certificate of their adoption by the Tellers.

Amendments to By-Laws

28. Amendments to the By-Laws may be proposed by the Board of Directors at any regularly called meeting thereof. Such amendments shall be adopted only after having been submitted by the Secretary by letter to the entire membership of the Board of Directors and having received the written approval of not less than a majority thereof.

Prematures With Mk. IV and V Point Detonating Fuzes

By

H. M. BRAYTON

A PREMATURE burst with a high explosive round of artillery ammunition is always a most serious matter and especially so when it occurs in the bore of the cannon. Even when the burst comes well outside the tube there is more or less danger from flying fragments and the occurrence always results in a careful study of conditions in order to locate, if possible, the cause of the trouble.

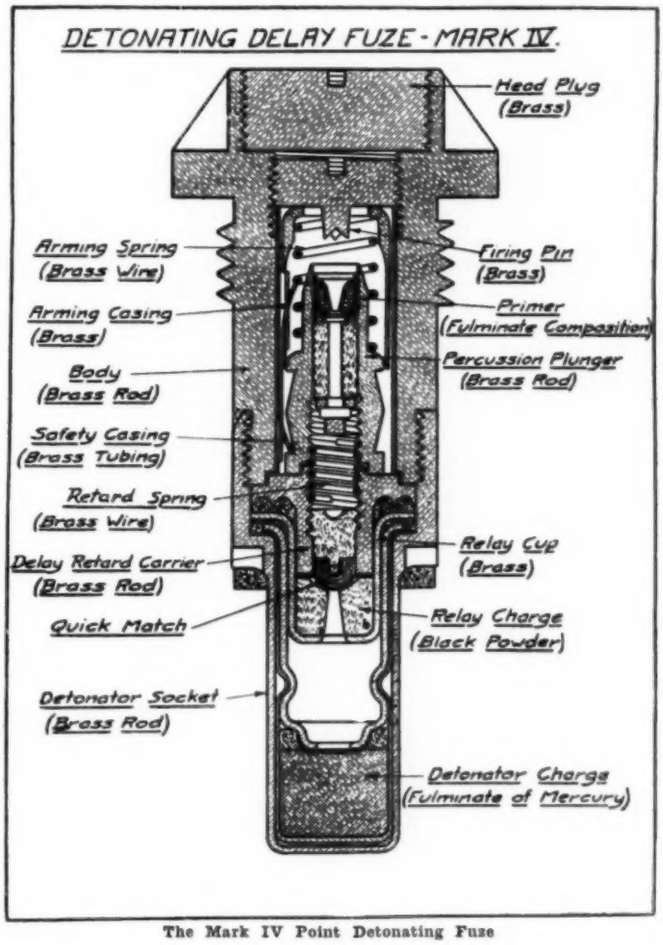
From time to time since the War high order prematures have occurred when firing explosive projectile fitted with Mk. IV and V point detonating fuzes. These prematures have not been confined to any particular type, as the Mk. IV, IV star and Mk. V, both delay and non-delay, have been involved. Nor is this faulty action confined to the fuzes loaded by any particular manufacturer. The natural conclusion reached from the study of a number of such prematures is that they are referable to several features of the design.

In the first place these fuzes are not bore safe. The 30 grain detonator of mercury fulminate is in direct line with the booster. Mercury fulminate is sensitive to shock and may be set off by the set back in the bore when the gun is fired. If this occurs the shell charge is detonated with high order while the projectile is in the bore, with the result that the gun is completely ruptured. When premature bursts within the gun occur they are usually due to this cause.

It is fortunate, however, that most of the premature bursts have taken place outside the bore. In this case the exact location or distance from the muzzle is of special value to the investigators. The type of fuze used must also be carefully considered. It has been the custom in the past to blame the retard spring whenever a premature of this kind occurred, but recent studies have shown that this component may after all not be the cause, except in rare instances. The delay timing record on the lot of fuzes from which the prematured was taken must be consulted in a study of this kind.

If a delay fuze, caused the premature and a reference to the timing record shows the minimum time for the lot to have been, say, .03 sec., any premature caused by a failure of the retard spring could not possibly occur closer to the muzzle than sixty feet. The point of zero linear acceleration occurs about ten feet in front of the muzzle and the negative acceleration of the projectile, and hence the maximum force of creep on the plunger, occurs just beyond this point. Even if the primer is fired there the projectile can not detonate for fifty feet or so further on when a delay of .03 sec. is present. There may, of course, be a longer delay.

It is possible that the primer is occasionally fired while the projectile is in the bore due to faulty loading. If this occurs with a delay fuze the burst would take place outside the bore but closer to the muzzle than if the primer were fired outside. If, however, the primer of a nondelay fuze is fired in the bore where the delay should not be over .004 sec. the burst should occur when the projectile is about one-third of the way out.



The Mark IV Point Detonating Fuze

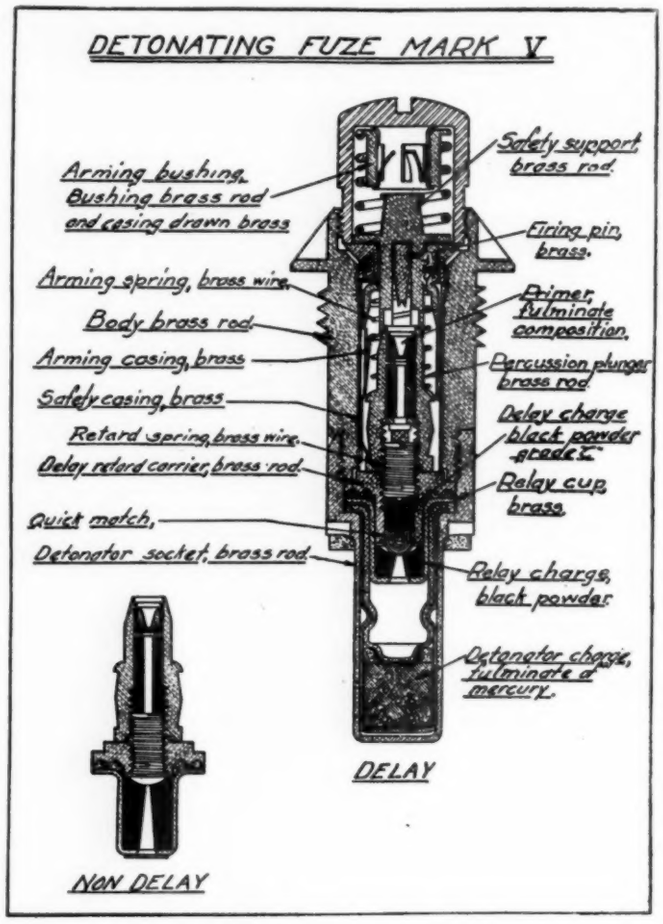
There have recently occurred at Aberdeen Proving Ground and at Fort Sill premature bursts of high order, in each case about seven feet in front of the muzzle. In both cases nondelay Mk. IV star fuzes were used. As the position of the burst was unusual, being so close to the gun, an intensive investigation has been made at Picatinny Arsenal in an effort to locate the cause. A considerable number of the retard springs from the same lot of fuzes were tested and all were found to be perfect. This was the first point investigated due to the position of the burst, although it was known that it should have occurred at a greater distance from the muzzle.

On the other hand, had the detonator been set off due to the shock of discharge it would have set

the shell charge off in the bore and destroyed the gun.

The problem seemed to baffle solution until some of the nondelay fuzes from the same lot were tested on the chronograph for time and it was found that many of them contained a very appreciable delay, even as high as .05 sec.

The cause of these prematures, therefore, seems reasonably clear. The primer, due perhaps to imperfect loading, was set off in the bore. The delay must have been around .01 to .015 sec. before the detonator went. This, fortunately, was sufficient time to permit the projectile to get out of the bore. This delay in nondelay fuzes has been definitely located in the primer and is due to hang fire. It occurs in primers of recent loading and in those which were loaded during the War. This condition in varying degrees is apparently present in all primers of this type and appears to be referable to the design. Work thus far carried out indicates that about 26 per cent of these primers will give a hang fire and thus a delay. When these primers are used in delay fuzes they add to the normal delay and thus increase dispersion. It can, therefore, be expected that in about one nondelay fuze out of four in which the primer is set off in the bore the projectile will get out of the tube before it is detonated. The other three will blow up the gun.



The Mark V Point Detonating Fuze

In 1917, the regular Mk IV fuze which has a retard spring requiring between 1.1 and 1.32 lbs. to spread it .236-inch was to be used in howitzers and the Mk IV start fuze which had a retard spring giving between 3½ and 4 lbs. in the high velocity guns. It was then pointed out that we needed the Mk V fuze differing from the Mk IV only by the addition of the extra safety feature in the head.

The results of a mathematical determination of the force of creep acting on the plunger in these three fuzes when fired in the various guns and howitzers in our Army Service based on 10° yaw is given in the table below.

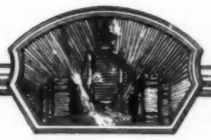
This study shows that the maximum force of creep on the plunger occurs when the fuzes are fired in the 6-inch gun and that this force is 0.191 lbs. As the strength of the creep spring for the regular Mk IV fuze and also for the Mk V fuze is between 1.1 and 1.32 lbs., it is clear that these fuzes would be perfectly satisfactory in this caliber. The minimum factor of safety is about 5.7. The Mk IV star fuze with its much stronger creep spring giving a factor of safety of 18.3 is hardly needed.

It is also pointed out that the Mk V fuze which has the same creep spring as the regular Mk IV fuze is specified for the 75 mm. and 4.7-inch guns where the force of creep on the plunger, namely, 0.145 to 0.169 lbs., is nearly as great as in the 6-inch gun. The fact that the Mk V fuze has proven satisfactory in the 75 mm. gun is additional proof that the Mk IV star fuze is not needed in any of our cannon.

It is understood that occasional prematures have occurred in past firings when the regular Mk IV fuze was used in guns of high velocity. A premature outside the muzzle of the gun with this fuze can occur from several other causes which have been discussed above. Such prematures are not proof that the creep spring was of insufficient strength.

TABLE

Cannon	Model	Fuze	Force of Creep in lbs.
75-mm Gun	1897	Mk V PD	0.169
75-mm Gun	1916	"	0.153
	1917		
4.7" Gun	1906	"	0.145
			0.073
6" Gun	1897 M.		
	1900		
	1903	Mk IV Star	0.191
	1905		
155-mm Gun	1918	"	0.163
155-mm How.	1917	Mk IV	0.054
	1918		
8" Gun	1888	Mk IV Star	0.110
	1888 MII	"	0.155
8" How.	Mk VI	Mk IV	0.039
	Mk VIII½	"	0.053
9.2" How.	Mk I	"	0.029
	Mk II	"	0.095
240-mm How.	1918	"	0.051
10" Guns,	all	Mk IV Star	0.060 to 0.070



Editorials

The Sixth Annual Meeting

THE Sixth Annual Meeting of the Army Ordnance Association, which will be held at the Aberdeen Proving Ground on Friday, October 3, 1924, will be devoted largely to the chemistry of ordnance. Few realize the important relationship which exists between the chemical industry and ordnance. The average conception of the latter term includes guns, gun carriages and perhaps small arms. Ammunition, explosives, chemicals in this category are often passed by the way and little attention—save on the part of those who actually know—is ever given them.

But chemistry is one of the major concerns of ordnance and likewise ordnance should be one of the major concerns of chemistry. The fabulous requirements for chemical raw materials which the Ordnance Department was called upon to produce and procure during the World War were staggering to the imagination. It is safe to say that ordnance requirements for such chemicals as sulphuric acid, picric acid, sodium nitrate, nitric acid, phenol and other coal tar chemicals necessary for the explosives program far exceeded any one effort in this direction in the history of our country.

These are matters that are well known to the chemists of America. Many of them were actively engaged in the Ordnance Deparmtent during the War and returned to their civilian pursuits after the Armistice. Many others have gotten out of touch with the situation. In order that all may know what the Ordnance Department is doing the chemists of the country have been invited to attend this meeting of the Association. Invitations have been extended to the American Institute of Chemical Engineers, the Institute of Makers of Explosives, the National Defense Section of the American Society of Mechanical Engineers and many local sections of the American Chemical Society.

A large attendance both of members of the A. O. A. and of invited guests is expected. This should be one of the most entertaining and certainly one of the most important meetings of the Association. All members who can possibly do so are urged to attend. There will be a special train to bring members and guests from New York City and arrangements will be made for reduced fares from most points in the United States to Aberdeen. Meals will be served at the Proving Ground and, all in all, a most interesting gathering is anticipated. The complete arrangements as to the reduced fare certificates, train schedule, and the detailed program will be mailed to all members about September 22.

Elsewhere in this issue is given a tentative program of the demonstrations and exhibits as well as the arrangements for the business meeting of the Association. All members are especially urged to attend the business meeting, where all will have an opportunity of discussing the Association, its work, its membership, and its progress.

Today more than ever the old bugbear of unpreparedness is on the scene and demanding that we return to the lethargic state of "do-nothingism," that our national defense rest on tin soldiers and wooden guns. Let us make this meeting a big affair in every sense of the word so that the great work of industrial preparedness may continue to assist in the adequate defense of our country.

October 3, 1924, will mark the sixth anniversary of the founding of the A. O. A. Reserve this date. It will be a big event!

General Tripp on Industrial Defense

THE following remarks of General Guy E. Tripp, a Director of the Army Ordnance Association and President of the Westinghouse Electric and Manufacturing Company, are an accurate expression of the industrial aspects of national defense:—

"It is not only patriotic for American industry to cooperate whole-heartedly with the War Department in its plans for industrial defense, but it is one of the most practical things it can do.

"War lays a heavy hand on industry. It consumes its equipment, disorganizes its personnel, disrupts established methods, nullifies fundamental policies, causes unhealthy and malignant expansions, exhausts the energies of management, and in countless other ways injures and destroys. It is an unmitigated evil. There is not a stable industry in the country today that was actually benefited by the last war, in spite of immense sales and, in many cases, enormous prices.

"We cannot hope, of course, to eliminate completely these destructive effects of war. War is never welcomed by a nation like our own, but if it comes, industry must bear its share of the burdens. But at least we can try to reduce these burdens to the lowest possible minimum, and if we succeed, not only industry but the nation at large will gain greatly thereby.

"The industrial defense plans of the War Department are the direct result of our recent unpleasant experiences and form by far the most promising solution to the problem of rapid and facile industrial mobilization that has yet been put forward. They give to each manufacturer specific information as to what he will be expected to do in an emergency and permit him to work out at his leisure the most effective way of performing this task. In a word, they make possible the doing of good work for the nation under the best possible conditions instead of foreing the turning out of bad work under the worst possible conditions. Especially they eliminate, as far as such a thing can be done, the fly-by-night manufacturer, who upset markets, cornered supplies, preempted labor, clogged transportation, and was the real profiteer during the late war. With these plans fully developed, American industry will master its own situation, and if put to the test will go at its work calmly but rapidly and without hysteria or visions of sudden wealth.

"These plans are, of course, not complete nor perfect. We hope to test them during the coming week, and to remedy the weak spots that are sure to develop. Four or five more years of this kind of experimentation will probably be needed before we can be satisfied that all is shipshape. Thereafter, we shall only have to keep the machinery well oiled and provide for new developments.

"American industry, I feel sure, holds these views, and I venture to guarantee here that it will make every proper effort to bring these vitally important plans to perfection."

Bethlehem Steel and Defense Day

THE following statement of Mr. E. C. Grace, President of the Bethlehem Steel Corporation, appears in the current issue of *The Bethlehem Review*. Everyone knows the gigantic role played by Bethlehem in furnishing munitions to the United States and the Allied Governments during the World War. Its policy as to national defense is expressed in a most commendable and patriotic way: those who know by experience the economic waste of unpreparedness are among the foremost endorsers of National Defense Day. The statement by Mr. Grace follows:

"September 12 has been designated as National Defense Day. The movement for national preparedness is parallel in a national way to what we are doing locally in our own organization. Preparedness for Bethlehem means the careful maintenance and expansion of our plants so that we may produce steel and iron to meet the needs of a growing population. It means the elimination of waste in our shops, mills and mines. It means building and maintaining our forces so that we will always be ready for maximum production. Preparedness means the budgeting of our expenditures; it means a 'Bethlehem' program which will produce the maximum in quality and quantity of steel at a minimum of cost.

"National preparedness means the organization, behind our first lines of defense, of a citizenship instructed in national self-protection and an industrial organization prepared to act quickly in case of national emergency.

"During the World War the entire facilities of the Bethlehem Steel Corporation were devoted to the manufacture of supplies at the direction of our Government. Today Bethlehem is devoted to the manufacture of commercial products, but the corporation with all its employes—the great majority of whom are American citizens—will co-operate with our Government in whatever measures of national industrial preparedness are necessary to preserve continued peace."

Who's Who in This Issue

MAJOR GENERAL ROBERT LEE BULLARD, Commanding General of the Second Corps Area, whose address on "The Significance of Defense Day" appears in this issue of Army Ordnance, is one of the outstanding military figures of the World War. With the rank of Lieutenant General he commanded the Third Corps on the Western Front where his ability and heroism merited the admiration of the entire world.

Dean Herman Schneider, who ranks as one of the prominent economists of the present day, contributes to this issue an article on "Factors Which Limit the Size of Our Army in War." Professor Schneider is Dean of the College of Engineering and Commerce, University of Cincinnati. He rendered conspicuous service during the World War in the adjustment of the complex transportation problems of those days.

Major Henry Erwin, who describes the Ordnance Reserve Officers Training Camp at Aberdeen, is an ardent devotee of all that pertains to ordnance. A financier of high standing, Major Erwin filled important posts in the Ordnance Department during the War. He has always been a most enthusiastic member of the Ordnance Reserve Corps and of the Army Ordnance Association.

Captain George W. Outland is one of the ordnance officers who conducted the Reserve Officers' Camp at Rock Island Arsenal. He gives an interesting account of the courses pursued at the Arsenal and of their benefit to the student officers.

Captain W. W. de Sveshnikoff, co-author with Mr. H. E. Haring of the article on "Electroplating Worn Machine Gun Barrels," is a frequent contributor to these pages. A member of the Russian Military High Commission to the United States, 1916-1917, he is now acting as an associate physicist on the staff of the Bureau of Standards.

Mr. H. E. Haring, who has collaborated with Dr. de Sveshnikoff in the problem of electroplating worn machine gun barrels, is an associate chemist at the Bureau of Standards. His specialty is the investigation and development of electroplating methods.

Colonel John Q. Tilson, Representative in Congress from the Third District of Connecticut, submits a graph showing the "Genealogy of the New England Gun Makers."

Dr. Charles E. Munroe submits a valuable piece of ordnance literature in his translation of M. Muraour's paper on "The Purification of TNT." Dr. Munroe is a life-long student of explosives and has always been keenly interested in the military aspects and uses of explosives materials.

Dr. I. C. Gardner is a physicist on the staff of the Bureau of Standards. He has done a great deal of very valuable work on the development of optical glass and optical systems for the bureau. His paper on "The Standardization of Optical Fire Control Instruments" has the savor of practical experience.

Fred Olsen, a chemical engineer at Picatinny Arsenal, propounds an interesting and, so far as we are aware, an entirely new theory in his paper, "Concerning the Theory of Detonation." His hypotheses are the results of his own research and they should be of considerable interest to explosive chemists throughout the world.

Major F. H. Miles, Jr., is Chief of Manufacture at Picatinny Arsenal. He is chairman of a board of ordnance officers appointed to investigate the recent fire at the Old Hickory Ordnance Reserve Depot.

Lieutenant Philip Schwartz is a member of the Coast Artillery Board at Fort Munroe. His article on "Accuracy Firing" is a timely discussion of this important topic in which the author is very proficient.

Mr. G. C. Hale is chief chemist at Picatinny Arsenal. Immediately after the War he was stationed at Coblenz and had charge of the examination of captured German ammunition under the direction of the Ordnance Officer of the American Forces in Germany.

Mr. H. M. Brayton is an ordnance engineer at Picatinny Arsenal, where he has done considerable work in the field of interior ballistics and fuze design. His paper on "Prematures With Mark IV and V Point Detonating Fuzes" should be of considerable interest to those who are actively engaged with the firings of these fuzes as well as to members of the Reserve Corps and to manufacturers.

Professional Notes

ARTILLERY DIVISION

Test of 14-inch Gun Railway Mount, Model 1920

THE firing tests of the 14-inch gun railway mount, model of 1920 (Fig. 1), have been completed at the Aberdeen Proving Ground. The mount was first tested on the 360° traverse concrete platform. When the mount is on the concrete platform, the trucks are removed. The power plant consisting of a Sterling engine directly connected with a 50 K. W. generator is located on the front trucks, which, after removal, are run a short distance away from the mount. Flexible electric cables are used to connect the power plant with the motors on the carriage.

A rapidity test consisting of firing 5 rounds was conducted. Starting with the projectile and powder on the ground, breech block closed, the total time required to fire 5 shots was 5 minutes and 13 seconds. The proof officer stated in his report that it was necessary to suspend firing for about 15 seconds, as in operating the projectile ammunition hoist the cable came off the sheave.

It is therefore believed that there will be no difficulty in obtaining a rate of fire of 1 shot per minute with this mount after slight modifications have been made.

The carriage was also recently fired a number of rounds from the ground platform. The carriage was found to be very stable on the ground platform even at low angles of elevation. The movement of the carriage on the ground platform is very slight.

The firing tests indicate that the mount should meet expectations as regards strength and stability.

The 4.7-inch Gun Motor Carriage, Mk. X.

THE 4.7-inch gun motor carriage Mk. X, or Corps motor carriage, was recently completed at the Rock Island Arsenal and shipped to the Aberdeen Proving Ground for test. This carriage is the last of a series of motor carriages built in accordance with the recommendation in the Caliber Board report, and is the first motor carriage built in this country for Corps Artillery. Its performance on test will be watched with great interest not only by the using services from a service standpoint, but by the Ordnance Department for performance and operating characteristics.

The motor carriage weighs complete 25,000 pounds and has a maximum speed of 8½ m. p. h. at 1,200 r. p. m., engine speed. The overall height has been kept low by the use of a special type of engine in which the cylinders are inclined to one side. This permits of a low trunion height and gives good stability in firing.

Stability is insured by the use of outriggers. These are necessary on this type of carriage where the gun is mounted to the rear of the carriage and is loaded from the ground.

The track is of the hinge-pin type similar to the usual type of construction, except that in this carriage, special metals are used in the pin in an effort to determine the relation between mileage and wear of track pins.

The truck frames are of the split type in order to allow the track to better follow the ground and permit of better equalization of the weight of the carriage. A more detailed description of this carriage will be given in an early issue of ARMY ORDNANCE.

The British Infantry Accompanying Gun.

THE following account of the British Infantry accompanying Gun is of interest:

The General Staff has had under consideration the two questions of:—

(a). A suitable artillery weapon for the close support of infantry.

(b). The most suitable weapon for defence of the forward infantry against tanks.

The conclusion arrived at is, that, for the present, the 3.7-inch howitzer, adapted to fit these roles with split trail and wide traverse (40 degrees), and comparatively heavy shell (20-lb.) can fulfill both functions. The immediate requisites are:—

Fig. 1. Testing 14-inch Gun, Railway Mount, Model 1920

(1). A modification on occasions of the means of transport and of the carriage of ammunition, principally to render the subsection more inconspicuous in action and in the approach to action.

(2). An organization suitable to and within the Infantry Division.

(3). A projectile capable at reasonable ranges of rendering innocuous any tank likely to be produced in the near future.

As regards (1) the Southern and Aldershot Commands are each carrying out a continuous trial with an equipment with "shortened shaft draught," which is drawn by one mule. The rear (or spade) portion of the jointed trail of the carriage is removed and the front portion is fitted with shafts which have an attachment for "farmers' draught," the saddle and harness being also modified. The shield is removed as also, to avoid damage, is the traversing gear, and the weight behind the mule is approximately 10-cwt. By this method the carriage on which the howitzer is mounted is followed by the mule carrying "trail, rear portion," by the "shield and slipper" mule carrying the shield and traversing gear, and by three ammunition mules each carrying eight complete rounds in two ammunition boxes. Thus the piece can be brought into action rapidly and with a reasonable amount of ammunition.

2. The carriage of the 3.7-inch howitzer was not designed to stand continual travelling on its own wheels, which causes greater stresses than those due to firing; but trials have shown that few modifications are necessary to render the equipment capable of such movement. These modifications are under consideration.

An establishment has been drawn up for the battery which permits a ready change from pack to draught and vice versa.

Five mules are allotted to each sub-section, which, with the three with the piece when in draught provide the eight required to transport the howitzer and carriage in pack. These five mules are intended to be used for ammunition supply in action, and in this connection modified saddles and ammunition boxes are being considered.

The remainder of the ammunition with the battery (90 rounds per gun) and the veterinary, artificers, and signalling stores (with the exception of one mule per section with telephone gear) are carried in L. G. S. wagons. A water cart, mess cart, and kitchen, travelling, are allotted to each battery and a mess cart and Maltese cart to brigade headquarters.

One pack brigade of three batteries will be included in each division, and the batteries (which can each be affiliated to an infantry brigade when desired) are organized with headquarters and two sections, each of two howitzers. Each of these sections represents a complete artillery fire unit (a "2-gun battery") and is organized for independent action, having two officers and an ample staff for reconnaissance, observation and signalling.

Consequent on this divisional organization a pack artillery section is included in the divisional ammunition column (L. G. S. wagons carrying 90 rounds per howitzer); the signal section is provided in the divisional signals and the necessary additions are made to the divisional train.

3. In addition to the need of a projectile (H.E.) capable of dealing with enemy tactical points which may hold up the advance, the "infantry accompanying" weapon may require a purely man-killing projectile such as shrapnel.

The question as to whether this nature of projectile shall form part of the equipment ammunition for this weapon has not been definitely decided, but it will certainly required on occasions.

The main points to be considered in regard to the use of shrapnel are:—

(a) The muzzle velocity of the howitzer should be such that the remaining velocity at a medium range will be sufficient to induce in the bullets the striking energy requisite for man-killing.

(b) The pressure in the howitzer must be sufficient to cause the selected fuze to "arm."

With existing fuzes these conditions are only obtainable in the 3.7-inch howitzer with the fifth charge (maximum muzzle velocity). The No. 80 fuze is better in these respects than the No. 88, and has, for reasons of economy and simplification of supply, been accepted as the fuze to be used for the present.

It is, however, recognized that with lower charges and greater height of trajectory the carriage is less unsteady and the difficulty of clearing crests is reduced, so that a newer design fuze is under consideration, which it is hoped will meet requirements.

A fuze indicator for fuzes No. 80 and No. 88 has been produced. (Quarterly Summary, No. 9).

4. In Quarterly Summary, No. 9, a penetration table has been included which shows that, provided the shell does not detonate, the 3.7-inch howitzer projectile with a graze may be expected to penetrate a 1-inch plate at 30 degrees to the normal at a range of 1,200 yards, full charge.

Actual trials have taken place and penetration at 30 degrees to the normal has been effected through a half-inch plate with a plugged lyddite shell (fitted with burnt-out fuze), and with a lyddite shell with 101 B fuze at some 1,350 yards at a velocity representing the remaining velocity with full charge.

The 1-inch plate has not been actually penetrated at this range and from the results of recent trials, it is doubtful whether penetration will be obtained with ordinary designs of H. E. shell. To avoid detonation some form of plugged shell would appear necessary, thus complicating the difficulties of what is already a somewhat meagre supply of H. E. and shrapnel.

It has, however, been shown from recent trials, an account of which is given in Quarterly Summary No. 11, that it is not always necessary to penetrate the armour in order to render a tank ineffective, but that the detonation of a 3.7-inch H. E. shell against or under the tank will often suffice to stop it and enable it to be dealt with at leisure." (*The Journal of the Royal Artillery*, May, 1924, Vol. LI, No. 2.)

Aiming Mirrors

TWO types of aiming mirrors have recently been manufactured by the Frankford Arsenal for test as to probable value for service use.

These devices are for use in laying gun carriages in azimuth in relation to an aiming point or target, accomplished by reflecting the image of the aiming point or target in the mirror so it may be viewed and definitely located through the telescope mounted on the gun carriage. With the mirror surface set, properly and carefully levelled, and rigidly mounted, and the gun telescope reading noted, the gun carriage can be trained accurately in the desired angular relation with the target, in the same manner as if the target were viewed directly by the telescope. With such a device, the gun may be emplaced lower than

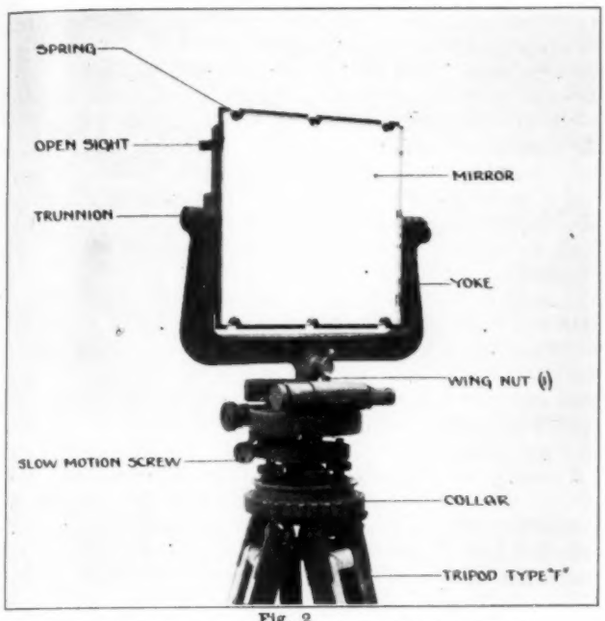


Fig. 2
Aiming Mirror, Type A, Mounted on Tripod, Type F

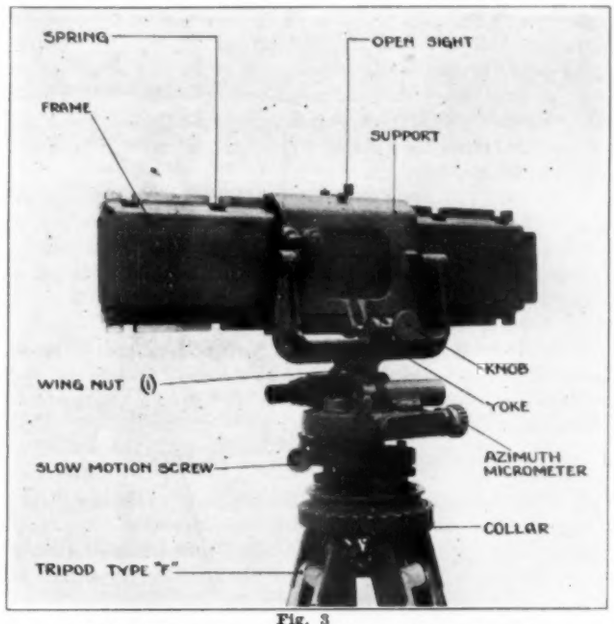


Fig. 3
Aiming Mirror, Type B, Mounted on Tripod, Type F

the surrounding terrain under conditions which would make the direct observation of target or aiming point impossible.

The instrument can also be used for registration purposes, registering the azimuth of the gun carriage after the laying has been accomplished in the usual manner. In this manner, the image of the panoramic sight mounted on the carriage is viewed reflected in the mirror by the observer at the panoramic sight. Shifting of position of the gun carriage can therefore be noted and measured, and compensated for in succeeding rounds.

The Type A instrument (Fig. 2) has a square silvered glass mirror, mounted to swing around a pair of horizontal trunnions. The Type B instrument (Fig. 3) has a rectangular silvered glass mirror mounted so as to be capable of sliding longitudinally on suitable guide rails. This feature insures that the reflected images can be picked up by the telescope, even with extreme shifting of the gun's position. Rotation about the vertical axis of the two types is given by the azimuth mount, which also contains the levelling mechanism. Provision has been made on the experimental models for the use either of a rigid tripod mounting or a stake mounting.

It was the original intention to use stellite for the reflecting surfaces. This material, practically a high grade of tool steel, is capable of taking a high polish and retaining its finish. It is not fragile as a glass mirror would be, nor is there the difficulty of securing a plate of sufficient size with both flat faces parallel. There is not the chance of warping due to unequal pressure exerted in mounting, as would happen with glass. Then, the ordinary mirror reflects an image at two surfaces, the face, and the real silvered portion. Due to the cost of the stellite, and the immediate availability of the glass mirrors, the latter were used for the experimental models.

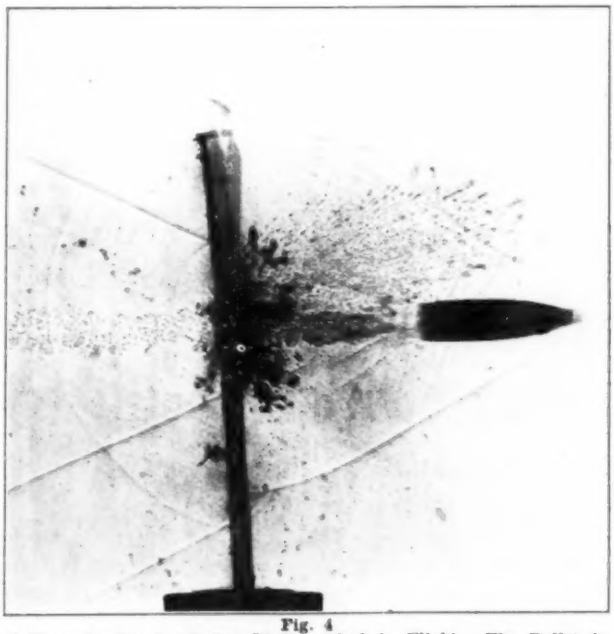


Fig. 4
Caliber .30 Service Bullet Photographed in Flight. The Bullet is Shown Immediately After Penetrating a Soft Steel Plate

INFANTRY AND AIRCRAFT ARMAMENT DIVISION

Charpy Test of Armor-Piercing Ammunition

IN the past, the penetrating qualities of armor-piercing ammunition have been determined by firing tests against armor plate. This method has been found very unsatisfactory for numerous reasons, primarily because it has been a difficult problem to obtain a sufficient supply of uniform armor plate, and as the character of the armor plate is specified by its Brinell hardness, it has been found that plates of the same hardness often give widely different results as to penetration. In addition to the considerable expense involved in conducting these tests, the method employed is dangerous at short ranges, due to the rebounding qualities of the steel cores.

After a careful study of this problem, Frankford arsenal arrived at the opinion that a definite relation existed between the penetrating and physical qualities of the armor-piercing

cores, and these qualities could be determined by certain physical tests, such as the Charpy or other impact tests.

As it is believed the penetrating effect of steel cores will be determined by heat treatment, the degree to which the Charpy test will determine penetrating qualities resolves itself into the efficiency of this test to differentiate between heat treatments.

With this in view, a program has been drawn up at Watertown Arsenal for conducting a series of Charpy tests on armor-piercing cores of varying heat treatments, and similar tests will be conducted at Frankford Arsenal using the Rockwell hardness tests.

If it is proven that small variations of heat treatment can be detected by either method, firing tests will be made with cores of varying heat treatments to determine the actual penetrating quality as compared to the Charpy and Rockwell readings.

Photography of Bullets in Flight

IN 1919 the Ordnance Department inaugurated an investigation of the air phenomena surrounding bullets in flight. Taking advantage of the observations already made on this subject by some of the leading physicists of the world, Frankford Arsenal made a careful study of numerous types of apparatus applicable to this work.

The study of apparatus has narrowed down to two machines, one devised by the Bureau of Standards and one modified by Frankford Arsenal. These machines have been set up at Frankford Arsenal, and while the latter is now in condition to take photographs, it is expected to calibrate the machine and experiment with the use of a pin hole aperture, different materials for spark points, and various types of photographic plates. It is believed that valuable information can be obtained with this apparatus, which will enable a better study to be made of the streamlines and the yaw of bullets in flight, which study should lead to the development of ammunition of longer range and greater accuracy.

Tracer Ammunition

CONSIDERABLE work has been conducted at Frankford Arsenal to develop a .30 caliber short range tracer, suitable for aircraft work, and a .30 caliber long range tracer to meet the requirements of the Infantry. The War time tracer bullet is considered unsuitable because, in addition to its erratic and erosive qualities, its maximum tracing ability of 500 yards is deemed insufficient for infantry purposes.

The Arsenal has developed a 500-yard tracer bullet, which, from firing tests, appears to meet the specifications made by the Air Service.

A red tracer bullet, capable of tracing 1500 yards, has also been developed, and firing tests so far conducted have indicated promising results.

Development, at Frankford Arsenal, of a suitable composition for a .50 caliber tracer cartridge has progressed to the stage of firing tests. Two types of bullets are at present under consideration, one representing an enlarged .30 caliber tracer bullet and the other having a solid brass container.

PICATINNY ARSENAL

Use of Zinc Rotating Bands by the Germans

THE shortage of copper in Germany during the War and the great demand for it in the manufacture of ammunition led to an extreme effort to develop suitable substitutes for this metal. Long before the close of the War evidence of this was given by various components of the complete round of ammunition, in which a variety of alloys or metals were used in place of the customary copper or copper alloys. At first, time fuzes appeared, made partly of brass and partly of aluminum, later the brass was eliminated entirely in favor of aluminum and aluminum-zinc alloys. Cartridge cases, originally made of brass with a high copper content, were so constructed that the lower portion only consisted of brass while the upper portion was of steel. Later, cases made wholly of steel were introduced.

This effort to reduce the consumption of copper to a minimum led even to the use of substitute metals or alloys for the rotating bands of many types of artillery shell. The schemes that were adopted in the use of these substitutes are not without interest in showing the extent to which long established practice can be modified when stern necessity demands.

Experiments were first carried out at Spandau and Strassburg, on the manufacture of shell, provided with pressed rotating bands made of zinc-aluminum alloy. The operation was found practicable from a manufacturing standpoint and after extensive firing tests at Wahn in 1916, shell fitted with such bands were issued to the Field Artillery. It was claimed that these experimental firings showed that the ammunition, from the standpoint of ballistics, was no different from that provided with the copper rotating bands. However, the increased hardness of the zinc-alloy bands over that of copper caused a much greater wearing of the lands of the gun barrel and an effort was made to overcome this by changing the composition of the alloy and also decreasing the amount of pressing that was at first found necessary to fix the bands in place. This effort proved to be only partially successful.

In the process of fitting the zinc bands to the shell, the bands were first submerged in a bath of oil which was heated to a temperature of 280° C. The bands were pressed immediately upon removal from the bath, for it was necessary that they have a temperature of at least 250° C. during the pressing operation. The pressing was done in the same manner as with the regular copper bands.

Since the melting point of the zinc bands was considerably lower than that of copper, it was necessary to protect the bands from the action of the powder gases when the shells were fired. This was done by placing a hard pasteboard ring or band just behind the zinc rotating band. The pasteboard rings were held in place by means of magnesia cement. It was necessary next to protect the paper rings from damage, which might occur during transportation of the shell, and for this purpose a ring of soft sheet iron was placed behind the paper ring and made fast to the latter by means of cement. The paper and sheet iron protecting rings were not fitted to the shell until after they were loaded and ready for shipment. It was absolutely necessary that the paper ring be present and undamaged when a shell was fired but the iron ring served no special purpose in this connection, and the shells were fired even though the iron bands became detached during transportation to the front.

Another type of rotating bands used extensively by the Germans was the so-called *"Kupferpanzerstahl"* bands. These consisted of steel with an outer layer or covering of copper, the two metals existing in approximately the same proportion. These bands were pressed into the grooves of the shell in the same manner as the regular copper bands, the steel portion serving to fasten the band into the groove, thus leaving the outer portion as the guide for the shell. By using steel for that portion of the band which was pressed in the groove, a saving of copper was ef-

feeted, while the band served its purpose ballistically the same as if it were all of copper.

The copper and steel were welded together by a special process which it has been learned was somewhat as follows: Steel bars approximately 48 inches long, 3 inches wide and 0.8 inch thick were suspended vertically in a muffle furnace filled with nitrogen and heated above the melting point of copper. The steel bars after reaching the required temperature were passed through the bottom of the furnace into a special cast iron mould. Molten copper was then poured into the mould. The molten copper coming in contact with the unoxidized surface of the steel bar, was firmly welded to the steel upon cooling. After cooling to a certain extent, the bars were removed from the mould and transported by a crane to the mill where they were milled down to about the proper size for the bands; they were later finished by drawing. Strips of the proper length for the bands were cut off by a special cutting machine.

The use of zinc-alloy and the *"Kupferpanzerstahl"* bands is merely one example of the originality shown by the technical men in Germany who were charged with the development of substitutes for the many materials which were not available in sufficient amount to meet the demands of the War.

MISCELLANEOUS

Modern Developments in Field Army Artilleries

EDITOR'S NOTE: The following comparative study of modern artillery development is the work of Major V. Drake-Brockman, R. A., and was published in *The Journal of the Royal Artillery*, May, 1924, Vol. LI, No. 2. The portions of the article which relate to American matériel are included in order that the continuity of the comparison may not be destroyed although American developments have been fully discussed in ARMY ORDNANCE (See especially "Artillery Design," by Brig. Gen. C. L'H. Ruggles, ARMY ORDNANCE, July-August, 1923, Vol. IV, No. 19, page 15, and September-October, 1923, Vol. IV, No. 20, page 101.)

IT is proposed in this article to deal with certain categories of artillery and related matters as follows:—

Wheeled Horse, Field and Accompanying Artillery.
Wheeled Medium and Heavy Artillery.
Wheeled Mountain Artillery.
Mechanicalised Artillery.

Since the war the general policy of all countries has necessarily been circumscribed by financial considerations. The lessons learned in the war have, however, served their purpose well, and practically all of the major powers are bending their energies to the experimental development of types of artillery of all calibres, which patterns when sealed can be put into manufacture at a moment's notice.

So far as is known no actual re-armament is in progress anywhere. Very large numbers of equipments manufactured during the war are in existence and all such as are sufficiently up-to-date are being retained to serve as a stand-by, until the more advanced experimental types can emerge. It might perhaps be as well to give a very brief résumé of the development of foreign artilleries up to the close of hostilities in 1918, before mention is made of more recent development so that a truer appreciation of the very great changes now taking place may be obtained.

FIELD ARTILLERY.

The period up to 1897 was that of the recoiling or semi-fixed carriage. Of this type were the Russian 90-mm. 1895 equipment, the German 77-mm. 1896, the Austrian 90-mm. of 1897, the Italian 75-mm. of 1901 equipment, and that of Japan of 1898. In all of these a variety of methods were employed to partially limit the movement of the carriage in action.

In 1897, the French 75-mm. equipment appeared and at once the artilleries of all the other Powers became moribund. Each nation set to work to re-design and a variety of Q.F. equipments were produced. For example the German 77-mm. 96 n/A with which they took the field in 1914, was a conversion of the original 1896 equipment, whose only merit lay in its lightness. So little at that time was the true value of the long recoil and air recuperator system appreciated, that Italy in 1901 retained a semi-fixed carriage, whilst Russia evolved an equipment in 1900 having an Indiarubber recuperator giving a comparatively short recoil; this was subsequently discarded in 1906 for a long recoil carriage with a spring recuperator. In the meantime, the firm of Schneider had developed their system of air recuperation. Very extensive trials were then carried out during 1901 and 1902 in America, 1903 in Switzerland, and 1907 in Greece, with a view to determining the relative merits of the spring recuperator (Krupp system), and the French system, with the result that Krupp equipments were supplied to Switzerland, Sweden, Denmark, Italy and Belgium, whilst the French firm obtained orders from Portugal, Spain, Bulgaria, Servia and Greece.

In all cases the arc of fire and elevation of these equipments were limited respectively to about eight degrees and sixteen degrees giving a maximum range on the carriage of approximately 6,500 yards. During the course of hostilities the necessity for increased range and arc of fire became more and more pronounced. The pressure of demand for anything and everything which would serve to meet immediate necessity was so great, however, that little could be done towards a new design. British firms alone produced an entirely new field equipment whilst the war was still in progress.

Since then enormous strides have been made in range, arc of fire, ballistics and mobility. Unfortunately very little information is available for countries other than America, France and Italy.

America.

Prior to the war the American field artillery was armed with a 3-inch equipment, model 1902. This was of conventional type having a single trail, spring recuperator, pivot traverse, non-independent line of sight. Later, the French 75-mm. was adopted and used during the war.

In 1918, a board of officers under General Westervelt, after a prolonged visit to France, laid down ideal requirements for artillery of all natures, and for the field artillery these were as follows:—

	Gun.	How.
Maximum and normal range	15000/11000	12000/10000
Elevation	80°	65°
Traverse	360°	360°

The first of the new equipments was designed in 1920 to take either the 75-mm. gun or the 105-mm. howitzer. This had a split trail, St. Chamond type H.P. recuperator, controlled length of recoil, rear trunnions with spring balanceers. Owing, however, to the excessive elevation given, 80 degrees for both gun and howitzer, and the fact that the carriage had to be made strong enough to take the howitzer as well as the gun, the weight proved to be excessive. Interchangeability of a field gun and a field howitzer is a difficult problem to settle satisfactorily.

A box trail design was then produced for the gun and howitzer separately. That for the gun was 800 lb. lighter

than the first design. It has a similar recuperator but with constant length of recoil, rear trunnions, independent line of sight and cross-axle traverse. The axletree is curved about the point of the spade to facilitate traverse, a design tried many years ago on a French 220-mm. howitzer and more recently in an 18-pr. of Beardmore design (1923). The muzzle preponderance is balanced by a single spring, placed underneath the cradle. The gun is laid for elevation by arc and spur gearing in a manner very similar to the British equipment.

The shielding of this American 1921 equipment is unusual in that the shield is carried well in rear of the axletree, almost at the point of the trunnions, with the result that the major portion of the gun, recoil system and elevating arcs lie exposed to the front.

The howitzer carriage in design is identical with the gun carriage and will be under 36 cwt. behind the team.

Concurrently with these two designs, a further split trail design for the 75-mm. gun has been produced which should be about 3 cwt. lighter than the original. In general design this model is very similar to our 3.7-inch howitzer but with independent line of sight and rear trunnions. Roller bearings also are freely employed on the trunnions, elevating shafts and round the stem of the pivot where it enters the axletree. The disposition of recoil and recuperator cylinders is unusual. The system generally is a modification of the French 75-mm. gun (Puteaux) type. The gun is carried in the center portion of a block, in the lower part of which is the liquid cylinder having the ram attached to the front part of the cradle. The liquid passes round the gun by passages to the upper cylinder in which is the floating piston. This arrangement brings the bore axis of the gun and the c.g. of the recoiling mass in close proximity, which is advantageous. The road clearance in the original design was 14 inches with a 48-inch wheel; this has been subsequently increased to 20 inches with a 56-inch wheel.

There is still a considerable difference of opinion in America as to whether the advantages obtained from a split trail compensate for the additional weight involved.

France.

The famous 1897 model equipment is too familiar to require special mention beyond the fact that in common with all single trail equipments, it suffers from lack of range and arc of fire.

The original 75-mm. was tentatively re-designed by Col Deport in 1908, but was not introduced. In this design the Abatage brakes were omitted and a spring spade arrangement similar to the British 15-pr. B.L. substituted. The buffer was purely pneumatic, and an independent line of sight on the Krupp arrangement introduced. The total weight behind the team was thus brought down from 39 cwt. to 33 cwt., with a view to arming the R.H.A. with this equipment. An experimental 75-mm. model was also tried in the 1901 French manoeuvres. This equipment had spring recuperation.

It appears to have been recognised that the Puteaux recuperator (75-mm. type) whilst excellently designed and still more excellently manufactured suffers from an excess of complication and is both expensive and difficult to make. The majority of other French equipments follow the standard design of the firm of Schneider.

At present, therefore, this French firm is developing field equipments with a view to increase of range without loss of mobility and are concentrating on the following types:

(1) 75-mm. gun. Range 13,500 yards. Max. Elev. 40°
(2) 105-mm. how. Range 11,000 yards. Max. Elev. 40°

The design includes a recoil mechanism similar to that of the 155-mm. howitzer, with rear trunnions and counterweight, non-independent line of sight, axle traverse. Generally, therefore, the design will follow the well-known Schneider type. The split trail although originated by the designer of the French 75 does not appear to have found favour.

Italy.

The war left Italy with a very large number of guns both of their own and of foreign makes captured during the war. In 1919, there was a general combing out of all undesirable types. The artillery accompanying the division will consist of 75-mm. gun arranged for pack transport and 100-mm. howitzers motorized. The split trail Deport 75-mm. equipment brought out in 1912 has not been generally adopted but will form a motorized reserve for the division.

Accompanying Artillery.

This form of artillery is a modern development, an outcome chiefly of the tank and machine gun emplacement. The ordinary field equipment is too heavy for the purpose. The only equipment successfully used during the war for this purpose was the German 96 n/A.

Italy.

A separate type of equipment is not looked on with such favour as in other countries, and although an equipment (details of which are given below) has been designed it is uncertain if any such will be adopted. At present the 75-mm. referred to above constitutes the infantry accompanying weapon.

A 70-mm. gun with a 6¼ lb. shell having an H. E. charge of 2¼ lb. m.v. 640 f.s., maximum range 1900 yards. The large amount of H.E. which is carried is due to the thin walled shell, which is possible on account of the low m.v. This shell will demolish barbed wire within 1 yard of the burst. The equipment breaks up into five loads, weighing from 51 to 101 lbs. Its total weight is 370 lbs. and it can be dragged over rough ground by one man.

America.

The Westervelt Board specified an equipment in which no component was to weigh more than 75 lbs., the total weight not being over 300 lbs.

The Americans in 1916 had adopted the French 37-mm. equipment and the 3-inch Stokes mortar. With a view, therefore, to a design suitable for an anti-tank gun and to replace the Stokes, a 1.8-inch gun and 2.24-inch howitzer on the same carriage were tried. These equipments were tried and abandoned and at present (1923) a 37-mm. gun and a 2.24-inch howitzer and the 75-mm. howitzer are under trial. The 37-mm. gun is a most notable advance in design when M.E. per lb. weight of equipment is considered. The rotation of the axletree to give traverse is a novel feature. The equipment has disc wheels to facilitate handling in muddy or marshy positions. The gun is drawn back for travelling and the tubular trail legs are telescopic. In draught the carriage is attached to a limber with shafts for one animal for ammunition.

The total weight in action is 350 lbs. and that of the limber with ammunition 300 lbs.

Medium and Heavy Artillery.

This class of artillery can hardly be said to have existed in any well defined degree prior to the war. It was during the period 1914-1918 that very great advance was made in the mobilization of the heavy guns and howitzers.

The Germans were in possession of 105-mm. and 150-mm.

guns and 150-mm. howitzers which were well improved during hostilities.

France possessed hardly any medium field artillery. The 105-mm. gun, 1913 Schneider, had only just appeared when war broke out. During the war an immense number of B.L. guns were hastily mounted on mobile carriages pending the manufacture of the more modern type Schneider equipments.

Towards the latter end of the war, French medium and heavy artillery consisted for the greater part of a variety of guns and howitzers from 105-mm. to 280-mm. Schneider, a certain number of the 145/155-mm. St. Chamond equipments and 155 and 194-mm. G.P.F.

No further developments of these classes are in progress.

The Americans were in possession of their 1906 4.7-inch gun at that time.

In view of present day development it is undoubted that the most notable advance in design was that of the G.P.F. type. This was due to Colonel Filloux and the design now forms the basis of modern development.

The equipment had many notable features which are being perpetuated and also suffered from certain defects. The latter comprised the necessity for a deep pit for the gun to recoil into at high angles, owing to the inadequate control of the length of recoil, and the disproportionate weight of the carriage compared to the ballistic effect of the gun due to keeping the recuperator block stationary during recoil and to the fact that in the case of the 155-mm. and 194-mm. respectively, the carriage is designed to take the gun bored out to 164-mm. and 220-mm.

Its notable features comprise:—A split trail, spring suspension of the weight on front and rear axles for travelling, a pressure fed buffer tank, rubber tired motor transport wheels of small diameter, excellent packing arrangements in buffer and recuperator and a very neat and compact form of reciprocating sight.

America.

The Westervelt board laid down the following particulars:—

	Medium Artillery.		Heavy Artillery	
	Gun.	How.	Gun.	How.
Caliber	4.7-inch.	155-mm.	155-mm.	8-inch. f
Projectile	60 lb.	100 lb.	100 lb.	240 lb.
Range	12000/18000	16000 (max.)	18000/25000	18000 (max.)
Weight	107 cwt.		268 cwt.	

It was also intimated that designs should be of the split trail type to mount gun or howitzer interchangeably and have rubber tired wheels for motor transport.

The 1920 designs for medium equipments fulfilled all the above conditions except as regards weight and for transport a separate wagon for the piece was provided. The lines followed very closely the G.P.F. with improvements in the axle suspension and reduction of time required to get into action. It also included pneumatic balancers, quick loading gear and roller bearing trunnions. Subsequently with a view to reduction in weight it was decided to forego the interchangeability of gun and howitzer, limit the elevation to 45°, and do away with variable recoil gear and quick loading mechanism in order to bring the weight limbered up below 107 cwt.

One carriage of this type has been made and is under trial. The shell weighs 50 lbs., m.v. 2450, range 20,500 yards.

The heavy artillery 155-mm. gun and 8-inch howitzer designs followed on parallel lines. It was found possible also to satisfactorily design one carriage to take both gun and howitzer. In this case, however, variable recoil and a quick loading gear has been retained. The quick loading gear locks the firing mechanism when the piece is brought down and in this respect follows current French practice.

A separate wagon is of course provided in each case for transport of the piece. The recoil mechanism both in this and the case of the medium artillery is of the same type as the G.P.F. control of length of recoil, therefore, follows on the same lines, viz., constant for low angles, controlled for medium angles and subsequently constant at the shortest length.

The most notable advances in the design from the point of view of service of the gun in both cases are:—

(1) Reduction of time to come into action.
(2) Reduction of size of pit required.

The first has been achieved largely by improvement in the method of unshackling the front axle spring suspension. In place of separate jacks as in the French equipment, screw jacks are permanently built into the axle. The method of attachment of the trail ends to the spade has also been improved. The latter by the adoption of rear trunnions and controlled recoil combined. A certain amount of digging is required, viz., a 15-inch pit at 65° compared with a 24-inch pit at 35 degrees for the 155-mm. G.P.F., which would have become 60 inches at 65° elevation.

Italy.

Italy appears to have discarded the idea of long range heavy artillery and is relying on the power of bombing aircraft to take its place.

Mountain Artillery.

The only developments proceeding in this class are those being carried out by America and France.

The French are proceeding with two designs with a view to economy in calibers, viz.:—

75-mm. gun ------ Range 9000 yards.
105 mm. how. ----- Range 6000 yards.

Each of these will be mounted on carriages having a box trail, cross-axle traverse and Schneider recoil mechanism. The gun carriage will have a cranked axle.

The Americans, in 1920, designed and manufactured a 75-mm. howitzer. The carriage has rear trunnions, the muzzle preponderance being taken up by a torque spring on the elevating shaft, a novel arrangement. St. Chamond recoil mechanism with variable recoil, axle traverse.

There are only four loads, no provision has been made for a shield. The loads are howitzer, cradle and recoil mechanism, wheels and axle, trail. The total weights respectively, including saddlery, are 310 lbs., 342 lbs., 294 lbs., 326 lbs. Weight of shell 15 lbs., range 6,500 yards, m.v. 900 f.s. This equipment was not considered satisfactory in trial and another was designed in 1922, having 9,000 yards range.

In the 1920 equipment, the howitzer was in one piece and the piston rods recoiled with it. Of the total weight 54 per cent recoiled. In the 1922 model the howitzer is in two parts and the piston rods remain stationary in recoil as in our equipments. The weight of the recoiling parts is increased to 80 per cent with a corresponding reduction in piston rod pull of 35 per cent. This makes a very great difference to the weight of the equipment.

Mechanical Transport.

The development of mechanical traction for all natures of artillery is proceeding rapidly. Prior to 1914 and during the war, commercial tractors and a certain number of caterpillar tractors were used, but the question did not receive deliberate attention until after 1918.

The *French*, in 1917, had, however, introduced platform caterpillar carriers for the 155-mm. class, and 75-mm.

guns were mounted on lorries for long distances. In addition to these, caterpillar carriers for heavy natures, viz., the 120-mm. and 194-mm. guns and 220-mm. and 280-mm. Schneider howitzers were constructed by St. Chamond during the latter part of the war. These equipments consisted of two separate vehicles with electric transmission, one carrying the gun and the other ammunition with motor and dynamo. In all, 75 equipments of this nature were completed.

The *Italians* also, towards the end of the war, had introduced a wheeled carrier for their 75-mm. guns.

Since then the Italians have developed experimental types for field artillery, concentrating on a tractor to move with infantry and a high powered pneumatic tired carrier for reserve artillery for long bounds. This latter can do 20 miles per hour with a radius of action of 300 miles. Later developments are on the lines of a pneumatic tired tractor to move at about 12 m.p.h., with the gun mounted on a single axle with pneumatic tired wheels and coupled up to the tractor by its own trail eye. This arrangement has been tried with calibers up to 150-mm. and has been moderately satisfactory. It appears, however, that in Italy no development is being made with caterpillar tractors, and wheeled carriages have not yet been equipped with rubber tired wheels.

In *America* very great developments are in hand. Two general types are under trial. The first is the conventional caterpillar track as manufactured by the Holt Manufacturing Company, and the other the "Christie" type. This latter is designed with four axles and a dismountable track. The wheels are rubber tired, and the arrangement is such that the car can operate on front and rear axles at high speeds without the track on roads, or with the track on the four axles across country.

Of the conventional caterpillar type there were originally three designs, viz., 2½-ton, 5-ton, and 10-ton. The first was for haulage of the field gun, the second and third for the medium and heavy artillery.

It was found that these tractors were hardly powerful enough for the work they were called upon to do. The present designs for hauling field, medium and heavy artillery are:—

Field Artillery—Weight 3 tons. Speed 12 to 16 m.p.h.

Medium Artillery—Weight 7 tons. Speed 12 m.p.h. (This type can pull its own weight at this speed on good roads.)

Heavy Artillery—Weight 15 tons. Speed 12 m.p.h.

In addition to these caterpillar tractors, designs of self-propelled mountings of the Holt type and Christie type have been made as follows:—

1. 75-mm. gun and 105-mm. howitzer interchangeably. This carriage has a maximum speed of 30 m.p.h. on a 45° slope and weighs complete 5¼ tons. This equipment did a 120 mile march over heavy country at a normal speed of 15 miles per hour developing a maximum of 30 m.p.h. The firing tests were very satisfactory.
2. 4.7-inch gun and 155-mm. howitzer interchangeably. Maximum speed 18 m.p.h., and weight complete 18½ tons.
3. 155-mm. gun and 8-inch howitzer interchangeably. Maximum speed 15 m.p.h., and weight complete 22 tons.

The Christie type has been designed and manufactured for the 155-mm. gun.

Speeds as high as 25 to 30 m.p.h., are now not considered either necessary or desirable. They involve the provision of a very powerful engine with consequent increase in weight, and further it is found that they result in almost prohibitive maintenance costs due to deterioration of the track.

In both of these types an effort has been made to render them amphibious by waterproofing the engine by either:—

(1) Separately proofing certain vital parts.
(2) Completely enclosing the engine in a waterproof casing.

The first method has proved to be a failure due to vibration on the roads which breaks down the tightness of the waterproof joints.

To illustrate the advance which has been made in mechanicalisation of artillery, the test carried out in America in 1922 may be cited. In this test ten 5-ton and twenty-eight 10-ton tractors (of the original type) were used to convey eight 155-mm. G.P.F. guns and six 8-inch howitzers with platforms, a distance of 600 miles over a variety of country, some being of very bad type. The trip occupied 40 days, of which 31 were spent in travelling, giving an average of 19½ miles per day; the longest one day run was 40 miles by the whole train, and on one occasion a 10-ton tractor towing a 10-ton trailer ran 83 miles in 30 hours. The whole column was entirely self contained and consisted of three convoys: (1) Provisioning, (2) Guns and Tractors, (3) Bridging and route maintenance. All repairs were carried out en route and only one tractor was abandoned at an Ordnance Depôt for special repair.

The total of vehicles of all sorts excluding the tractors was 265 and the personnel (including the gun convoy) 26 officers and 1030 other ranks.

The accompanying Table A, gives the main characteristics of typical field gun and howitzer equipments. In the case of medium and heavy artillery, designs are not sufficiently advanced to permit of any tabulation.

In the case of the 75-mm. gun the m.v. is for a supercharge, but in considering the equipment it must be taken into account that it has a possible range of over 15,000 yards.

It is evident that great strides have been made both in regard to range and arc of fire.

The weight in action of the American 1921 box trail equipment seems extraordinarily low, but the figures are as published. There is a steady diminution in wheel diameter and increase in track, and a simultaneous decrease in the number of rounds carried with the gun. These alterations (which would be more marked if comparison is made with the older B.L. types) are a direct result of increased ballistics.

The great increase in efficiency in design is very clearly brought out in the last two lines of the table.

Weight will always be of importance in field artillery guns and howitzers, which in action have always to be light enough to be handled by a limited number of men, and such advancements as increased elevation and traverse, independent line of sight and quick loading gears, all add weight, quite apart from increased m.v. and muzzle energy. The advent of mechanicalised field artillery has not done away with the old limiting weight factor, except possibly in the case of self-propelled mountings.

It is, however, in the class of medium and heavy artillery that the greatest strides have been made. Prior to the war, it was hardly considered as within the bounds of practicability to design wheeled artillery of calibers up to 6″ and 9.2″ howitzers to accompany the field army. The Germans and Austrians, as is well known, had manufactured heavy guns and still heavier howitzers which although transported in loads fired off their own wheels, and the French also had a limited number of heavy pieces.

And the large variety of medium and heavy guns and howitzers which appeared as emergency measures during the war proved not only the necessity but the practicability of this type of artillery. It must not be forgotten, however, that without efficient tractors or other mechanical transport the present day evolution of heavy artillery would not have been possible.

In considering the general advance in this class it will suffice to compare the following pre-war and post war designs. (See Tables A and B.)

The immense increase in effectiveness of corresponding calibres is very evident. The last column in Table B, as well as that in Table A, brings out very clearly the effect produced by various developments.

The criterion of ft./lbs. of M.E. per lb. of the equipment serves as a very useful comparison but requires discrimination in its application. The sudden drop from 535 to 361 in columns 4 and 5 of Table B does not indicate a falling off in design, but is wholly accounted for by the heavier ballistics of the gun and the increased arc of fire. Columns 5 and 6, however, are directly comparable, the improved efficiency being due to changes in the design of the carriage, details of which have been mentioned.

Perhaps the best example of progress, however, is a comparison of the British 9.2-inch howitzer and the American 8-inch howitzer. The M.E. of these equipments respectively are 455 and 517 ft./tons, the latter having an increased range of 5,000 yards and travelling in two loads, besides firing off its own wheels. The efficiency has risen from 196 to 425.

In Table A, it will be noticed that the figures are approximately the same for the French, British, German and American gun equipments of pre-war design. The later American equipments show greatly improved efficiency due almost entirely to the very large increase in M.E.

Development on the carriage side since 1914 has been very rapid. The milestones, so to speak, may be marked by the advent, firstly, of the French 75-mm. in 1897, followed in 1912 by the first split trail equipment, the Italian 75-mm., designed by Col. Deport, the originator of the French "75," and finally the G.P.F. type produced in 1918 by Col. Filloux. The year 1897 saw the first true Q.F. carriage with H.P. recuperator, subsequently adopted after many years by ourselves and America, whilst the Deport type split trail for field artillery, and the G.P.F. for medium and heavy, have immensely increased the effectiveness of these natures.—*The Journal of the Royal Artillery*, May, 1924, Vol. LI, No. 2.)

TABLE A

	FRENCH.	GERMAN.		BRITISH.		AMERICAN					
	75-mm.	96 n/A	F.K. 16	18 pdr. Mk. 1 gun.	4.5 in. how.	3 ins. gun.	75-mm. gun.	75-mm. gun.	75-mm. gun.	105-mm. howr.	105-mm. howr.
Date	1897	1905	1916	1905	1911	1902	1920	1921	1923	1920	1921
Calibre in inches	2.95	3.03	3.03	3.3	4.5	3	2.9	2.9	2.9	4.2	4.2
Bore length, calibres	34.5	27.3	35	28	13.3	28	42	42	42	31	——
Weight of shell, lbs.	15.9	15	15	18.5	35	15	15	15	13	33	33
M.V. (f.s.)	1740	1525	1745	1615	1010	1700	2175	2175	2175	1500	1500
M.E. (ft. tons)	336	244	320	335	250	301	495	495	495	520	520
Weight of gun	9.1	7.66	——	9	9	7	11	8.5	8.5	11.25	9
Weight in action	25.8	19.3	27.5	25	27	22.5	32.5	25	28	33	27
Weight in draught	39.5	35.6	45	40	41.5	33.8	43	35.5	39	——	——
Range (yards)	6900	8800	10400	6500	7000	6000	15000	15000	15000	12000	12000
Elevation	19°	16°	16°	16°	45°	15°	80°	45″	45°	80°	52°
Traverse	8°	8°	8°	8°	6°	8°	30°	10°	45°	30°	10°
Diameter of wheels	52″	53″	53″	56″	56″	56″	48″	48″	56″	48″	48″
Track	61″	60″	60″	63″	63″	60″	60″	60″	60″	60″	60″
Recoil	47	44	——	41	40/20	46	40/18	42		45	45
Pounds M.E. per lb. Action	260	252	232	268	185	268	313	400	353	316	386
Pounds M.E. per lb. Transport	170	136	142	167	120	——	232	282	254	——	——

TABLE B

	BRITISH.			AMERICAN.					
	60-pr. Gun. Mark I.	6-in.30-ct. How. Mark I.	9.2-in. How. Mark II.	4.7-in. Gun. 1906	4.7-in. Gun. 1920	4.7-in. Gun. 1921	155 m. m. How. 1920	155 m. m. Gun. 1920	8-in. How. 1920
Weight of Shell (lbs.)	60	100	290	45	50	50	100	95	200
M. V. (f/s)	2080	777	1500	2050	1850/2450	2450		2000/2800	1925
Range yards	10000	5200	13100	8860	20500	20500	16000	26000	18000
Arc of fire	8°	Nil.	60°	8°	60°	60°	60°	60°	60°
Loads in Transport	1	1	4	1	2	1	2	2	2
Weight in Action	4t. 8c. 11lb.	2t. 17c.	14t. 17c.	3t. 12c. 21	5t. 16c.	4¾ tons	6 tons	10t.14¼c.	12t. 4c.
Total Weight in Draught	5t. 4c. 2q.	4t. 5c. 2lb.	18t. 18c.	4t. 7c. 3q.	7t. 18c.	5t. 7c.	7t. 1c.	12t. 10c.	12t. 8c.
Ft/lbs. M.E. per lb. Weight in Action	412	147	196	535	361	442	—	487	425

THE DYE AND SYNTHETIC ORGANIC CHEMICAL INDUSTRY

The United States Tariff Commission will soon issue its seventh Annual Report on the Census of Dyes and Coal-Tar Chemicals for the calendar year 1924. This report shows a record output for the year 1923, with conspicuous progress in the production for the first time in this country of many important dyes and other synthetic organic chemicals, as well as a further reduction in selling prices.

The domestic production of dyes in 1923 by 88 firms was 93,667,524 pounds, the largest in the history of the domestic industry. During 1922 the output by 87 firms was 64,632,187 pounds. The total sales for 1923 were 86,567,446 pounds with a value of $47,223,161. Our pre-war production in the year 1914 by 7 firms was 6,619,729 pounds, valued at 2,470,096. The output was then dependent upon foreign countries, as most of the intermediates were imported—chiefly from Germany. Among the more important factors responsible for the large output in 1923 may be mentioned.

(1) The activity of the domestic textile and dye consuming industries.

(2) The occupation of the Ruhr, which caused a reduction in the output of the German dye factories and consequently enabled the domestic producers to increase their exports of indigo, sulfur black, and certain other dyes, principally to the markets of the Far East.

(3) The relatively high foreign price levels of dyes compared with those of the pre-war period.

The average sales price of all dyes for 1923 was $.545 per pound compared with $.60 in 1922, $.83 in 1921, and $1.26 in 1917, the first year for which a census of dyes and coal-tar chemicals was compiled by the Tariff Commission.

Production of New Dyes

During 1923 nearly 100 dyes were produced for which no production in the United States had been shown in 1922. In addition, other dyes, which had been reported previously in small quantities, were manufactured on a substantial commercial scale. These comprise for the most part dyes of the specialty type, of greater complexity and more difficult and costly to manufacture. New products include dyes for silk, cotton, wool, color lakes, and other purposes, and are representative of the different classes of dyes by chemical classification. The domestic industry, although deficient to some extent in the production of certain vat dyes and other colors, supplies over 95 per cent of the domestic requirements.

Record Output of Vat Dyes

The production of vat dyes (other than indigo), in 1923, was 1,766,383 pounds, the largest in the history of the industry, an increase of 690,391 pounds over that of 1922. This class of dyes produces shades of high fastness on cotton goods which will stand the modern laundry treatment. As the public is appreciating more and more the value and importance of fast dyes, the consumption of this group is increasing, and their increased production is a notable development of the domestic industry. The production of synthetic indigo during 1923 was 28,347,259 pounds.

Relation of Production to Consumption

The imports of synthetic dyes in 1923 were 3.3 per cent of the total production by quantity and 6.2 per cent by value. Imports were accordingly by quantity 3.9 per cent of the apparent consumption, assuming this to equal production plus imports minus exports. Dyes produced in the United States accordingly supplied about 96 per cent of the apparent consumption of coal-tar dyes, and there was, in addition, an exportable surplus of certain dyes amounting to about 18,000,000 pounds.

The output of dyes in 1923, grouped by classes according to the method of application, was as follows: acid dyes, 12,498,817 pounds, or 13.34 per cent of the total output; basic dyes, 4,157,373 pounds, or 4.44 per cent; direct cotton dyes, 16,858,387 pounds, or 18 per cent; mordant and chrome dyes, 4,078,504 pounds, or 4.35 per cent; sulfur dyes, 21,558,469 pounds, or 23.2 per cent; vat dyes, including indigo, 30,113,642 pounds, or 32.15 per cent; indigo, 28,347,259 pounds, or 30.26 per cent; other vat dyes, 1,766,383 pounds, or 1.89 per cent; lake and spirit-soluble dyes, 1,171,854 pounds, or 1.25 per cent; unclassified and specialty dyes, 3,230,478 pounds, or 3.45 per cent of the total.

Imports of Dyes Decline

Total imports of coal-tar dyes for 1923 were 3,098,193 pounds, valued at 3,151,363, compared with 3,982,631 pounds, valued at $5,243,257 for the year 1922. The total imports during 1913, previous to the extensive development of the domestic industry, were 45,950,895 pounds. Of the total imports during 1923, 47 per cent came from Germany, 28 per cent from Switzerland, 12 per cent from Italy, 6 per cent from France, 4 per cent from England, and 3 per cent from all other countries. Dye imports for the year 1923, classified by method of application, are as follows: acid dyes, 6,544,048 pounds; vat dyes, 1,207,554 pounds; mordant and chrome dyes, 453,415 pounds; direct dyes, 527,012 pounds; sulfur dyes, 114,023; basic dyes, 210,896 pounds; spirit-soluble and color lake dyes, 23,213 pounds; and all other dyes, 18,030 pounds. Those shipped from Italy appear to be of German manufacture and are doubtless dyes delivered to Italy from Germany in reparation payment and later resold to the United States. Italy received up to December 31, 1923, 6,274,601 kilos out of a total delivery by Germany in reparation payment of 25,583,390 kilos of coal-tar dyes.

Exports of Dyes Increase

The exports of coal-tar dyes during 1923 totaled 17,924,200 pounds with a value of $5,566,267, compared with a total of 8,344,187 pounds with a value of $3,996,443 during 1922. This increase in the domestic exports of coal-tar dyes may be largely accounted for by the effect of the occupation of the Ruhr by the French, which resulted in a decreased production of dyes in the German factories and consequently gave the domestic manufacturers an opportunity to increase their exports to the Far East markets.

International Dye Trade

Pre-War.—Prior to the war, Germany, with an output totaling three-fourths of all synthetic dyes produced, dominated the world's dye markets. Of the remaining one-fourth, one-half was made from German intermediates, and its production was accordingly dependent upon Germany, Switzerland, although without a domestic source of raw materials, ranked second, with about 7 per cent of the world's production. Great Britain produced about one-tenth of her requirements, and France produced in French-owned and operated plants from 10 to 15 per cent of her consumption. In order to meet the patent requirements of France and Great Britain, German manufacturers operated plants in those countries where the final

(Continued on page 544)

Reaffirming a Century Old Pledge

AS we go to press the following copy of a communication from Mr. Irenee duPont, President of E. I. duPont de Nemours and Company, addressed to Honorable John W. Weeks, Secretary of War, comes to hand. While ARMY ORDNANCE feels that this is but one of many notable contributions on the part of American industry to the accomplishments of Defense Day, it regrets that time and space are not available in this issue to publish adequate comment upon the full import of the magnificent rally of American industry to adequate national defense.

This much we must say. The duPont Company, since the very days of the infancy of our republic, has at all times rendered sterling service in the cause of preparedness. Eager in the development and manufacture of chemicals and explosives for the commercial pursuits of peace, the name duPont has stood as a bulwark in time of war as a guarantee that American defenders shall always have sufficient chemicals and explosives.

122 years ago, duPont started making powder for the United States; Defense Day, 1924, finds the same willing spirit of co-operation.

E. I. DU PONT DE NEMOURS & COMPANY
INCORPORATED
WILMINGTON, DELAWARE

EXECUTIVE OFFICES

September 12, 1924.

My Dear Mr. Secretary:

In recognition of the significance and objectives underlying the designation of this, the Twelfth of September, as National Defense Day and in view of this Company's desire to cooperate with our Government in the problems of industrial preparedness and also the mobilization of production facilities in the event of a war emergency, we held this morning a joint meeting of the Executive Committee and our Heads of Departments, at which the following resolution was unanimously adopted:-

"RESOLVED, that the Chairman appoint a Defense Day Committee to keep in touch with the various Departments of the U. S. Government and to formulate tentative plans for cooperation with the Government in case of a war emergency."

Pursuant to this action I have appointed the following to serve on this committee:-

Colonel William C. Spruance, Vice. Pres.-Chairman.
A. Felix duPont, V. P. & General Mgr.—Smokeless Powder Dept.
J. Thompson Brown, General Mgr.—Explosives Dept.
W. F. Harrington, General Mgr.—Dyestuffs Dept.
J. B. D. Edge, V. P. in charge of Purchasing & Traffic Depts.
H. M. Pierce, Chief Engineer.
Dr. C. M. A. Stine, Chemical Director.

I am taking the liberty of forwarding, without further comment, a copy of this letter to the gentlemen indicated herein below, for their information.

Please be assured that you and your staff may count at all times upon the individual and collective cooperation of this Company's organization.

Yours very truly,
IRENEE duPONT, President.

Hon. John W. Weeks,
Secretary of War,
Washington, D. C.

Copy to
Hon. Curtis D. Wilbur, Secretary of Navy.
Major General C. C. Williams, Chief of Ordnance, U. S. A.
Brigadier General Amos A. Fries, Chief of Chemical Warfare Service, U. S. A.
Hon. Benedict Crowell, President Army Ordnance Association.

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assembling operations were completed. The small dye industry of the United States was almost entirely dependent upon intermediates from Germany.

The acute shortage of dyes arising in the various dye-consuming markets, due to the disappearance of German dyes shortly after the beginning of the war, was soon followed by prices of unprecedented levels, while certain dyes were not to be had at any price. This dye famine threatened the activities of the vast textile industries as well as other industries dependent upon dyes for their operation. The manufacture of dyes was soon entered upon in the United States, Great Britain, France, and Italy, and each of these countries has developed a dye industry capable of supplying from 80 to over 90 per cent of its requirements and has, in addition, exported significant quantities of dyes since the war. As a result of this remarkable period of expansion and development, the world's present capacity to produce dyes is nearly double that of the pre-war period. The estimated annual capacity to produce dyes by the seven leading producers—Germany, United States, Great Britain, Switzerland, France, Japan, and Italy—is considerably in excess of 600,000,000 pounds. The maximum estimated or officially reported output of the seven leading dye producers as as follows: Germany (1913), 280,000,000 pounds; United States (1923), 94,000,000 pounds; Great Britain (1920), 43,000,000 pounds; Switzerland (1920), 24,000,000 pounds; France (1923), 24,000,000 pounds; Japan (1919), 16,000,000 pounds; and Italy (1922), 10,000,000 pounds. This existing capacity to produce over and above normal requirements is resulting in an era of severe competition in the world's markets, which may eliminate many of the plants now in operation. Owing to the position of supremacy held by the German industry prior to the war, the future position of Germany's industry in the world's trade is of peculiar interest. Her export trade has suffered severely as a result of developments during and since the war. In 1913, the German export of synthetic dyes amounted to about 240,000,000 pounds, with a value of about $52,000,000, while in 1922 it amounted to about 114,000,000 pounds with a value of about $80,000,000. For the year 1923 exports from that country totaled about 74,000,000 pounds, with a value of about $17,000,000 (1913 basis) or $42,000,000 (1923 basis).

A study of the imports and exports of the world's chief dye consuming and producing nations for the post-war years indicates the remarkable readjustment in the international dye trade due to developments during and since the war.—*(Indutsrial and Engineering Chemistry, September 10, 1924.)*

Electroplating Worn Machine Gun Barrels

(Continued from page 504)

but more probably is caused by occluded basic particles, for example, of the nickel carbonate used in the neutralization. Methods of testing and controlling the acidity, which have been developed since these experiments were conducted, would probably aid in overcoming this difficulty[6].

The formation of three layers (Fig. 3) in the nickel upon annealing to 1000° C., may be due to the alloying with the iron of the gun barrel on one side, and with the copper (used as a protective coating during polishing) on the other side. If such alloying with the steel does occur, it may result in increased adhesion. The evident effect of the annealing in increasing the grain size of the nickel must result in a reduction in its hardness, and thus probably reduce its service

Figures 4 and 5 show the structures of copper and of iron which were deposited upon the inner surface of short sections of the barrel. Of the various metals, copper is most easily deposited in a dense form, but its properties are not suitable for the present purpose. Iron deposits possess most of the same defects as those of nickel. More recent researches on iron deposition indicate possibilities for overcoming these defects.

Conclusion

From the preceding experiments it was concluded that with the information and methods then available the satisfactory lining of gun barrels by electrodeposition presented serious difficulties. Further experiments would be required to determine whether, with the present knowledge of the electrodeposition of nickel, cobalt, iron and chromium, more promising results could be secured. Not until the laboratory tests are successful will it be possible to determine whether such a process can be carried out commercially at a cost that will be justified by the advantages it may possess.

[6]M. R. Thompson, The Acidity of Nickel Depositing Solutions, Trans. Am. Electrochem. Soc. 41, 333 (1922).

Concerning the Nature of Detonation

(Continued from page 517)

intact, giving rise thereby to different types or orders of detonation. Such a condition is frequently met with in practical work and is generally attributed to weakness in the initiating system, or, in terms of the electronic conception of detonation, to the impinging of electrons of insufficiently high velocity to sever all the bonds. The possibility should not be ignored, however, that some materials may be auto-initiating as it were. By this it is intended to convey the idea that if the partial detonation of some of the molecules of the explosive material be effected, this partial severance of the molecules may result in the emission of electrons of sufficiently high velocity to break the remaining stronger inter-atomic bonds, thus effectively detonating the entire molecule.

The above hypotheses are being subjected to critical examination and the necessary experimental work may very shortly be under way. It would seem that the results may be very far reaching both as to interpreting such questions of military significance as the sensitivity of explosives and the action of booster materials, and also should at least indicate lines of attack on the very fundamental problem of the nature of the chemical bond.

Reserve Corps Notes

THE following have accepted commissions in the Ordnance Section, Officers' Reserve Corps, since the last issue of ARMY ORDNANCE.

Colonel—
John O. Johnson
Leiutenant Colonels—
Gardner Abbott
Watson M. Myers
Majors—
Frank Altschul
Addison F. Holmes
John L. Hughes
Albert G. Peter
Clark S. Robinson
Captains—
Richard C. Bodenhamer
Howard K. Coolidge
Arthur B. Domonoske
Walter S. Frost
George Hamill
Frank C. Locke
Herbert B. McKahin
William H. Milholland
James C. Patterson
Selden B. Sanford
Frederick R. Slater
War Van Alstyne
Claude W. Wright
Fred R. Zimmerman
First Lieutenants—
Winthrop P. Culver
Clyde B. Dempster
William L. Durrant
Carl E. Heimbrodt
Arthur E. Keating
Charles C. Lundy
Theodore W. Miller
Kenneth B. Page
Harold J. Preble
Benjamin D. Roddey
Second Lieutenants—
Edward B. Allen
Edward R. Atchison, Jr.
Laurence A. Barnes
Robert E. Beers
Edward D. Betts
Roland N. Black
Albert L. Bowen
Charles T. Brasfield, Jr.
William O. Britt, Jr.
John H. Brown
Charles L. Bullock
Nelson F. Caldwell
George R. Cary
Wellner L. Christian
John J. Chyle
William B. Coleman
Samuel E. Cotter
John J. J. Cox
Laurence M. Crannell
William M. Croft
Orris A. Cumming
John R. de Jarnette
Willard I. Deniston
Louis L. Dixon
Melvin C. Donkle
Delos E. Dudley
Carroll D. Edgar
Herbert H. Engemann
Andrew J. Fairbanks
Karl J. Fairbanks
Stuart O. Fiedler
Gordon C. Fowler
Gustaf A. Gafvert
Ernest Gaskins
John A. Gellatly
Frederick L. Gemmer
Stuart Gourley
Ernest W. Greene
Brett R. Hammond
Sargent D. Heath
John H. Henninger
Charles E. Herrstrom
Harold N. Hill
Warren E. Hill
Arthur S. Hillbrath
Helm C. Hussner
Edwin L. James
Darryl W. Johnson
Myron H. Johnstone
George W. Jones
Joseph D. Judge
Wilbur B. King
Howard G. Kitt
Clyde J. Koskinan
Lawrence C. Lander
Henry G. Leet
Geo. E. Lewis
James W. Longueuil
Norman L. Marden
Perry C. Maynard
John Millar
Albert R. Miller
Robert O. Miller
George W. Misner
William G. Mollenberg
Frederick J. Mollerus
Herbert C. Moore
Charles H. Morlath
Hudson T. Morton, Jr.
Nelson H. Mosher
Matthew F. Mountain
William A. Myers
Adam A. Nejako
Allen J. North
Thomas A. O'Brien
George D. O'Neill
Paul D. Parker
George H. Pfefferle
Ezra Posner
Delbert J. Quammen
Cecil H. Ramsey
William W. Randolph
Einer W. Rasmussen
Herbert J. Reich
Jay E. Rohrer
Dayton L. Robinson
Crandall Z. Rosecrans
Ralph S. Saunders
Elwood F. Searles
William E. Sickel, Jr.
Edwin A. Smith
Frank W. Smulley
Henry C. Snider
Richard E. Townsend
Walter R. Treff
Henry P. Vaughan
Joseph A. Walker
Frank O. Walsh
Walter C. Wardner
Russel H. Wellington
Alvin E. West
Nathaniel P. Wharton
Charles E. Wilder
Emil L. Woesner
Richard G. Wolfinger
Allen G. Woodruff, Jr.
John Wyllie
George L. Zamzow

The following Ordnance Reserve Officers have recently accepted reappointment:

Colonel—
James E. McNary
Lieutenant Colonels—
Lloyd G. McCrum
James G. Scrugham
Lionel D. Van Aken
William G. Wall
Albert E. White
Winthrop Withington
Frederick E. Wright
Majors—
Harold N. Blake
Harold S. Bope
Leon W. Chase
David B. Clark
Charles F. Derby
Arthur W. Ewell
Andrew L. Fabens
Charles H. Fessenden
Arthur Frantzen
William J. Hoffman
John J. Jackson, Jr.
John R. Jackson
Carl W. Jones
Edward M. Kerwin
Frederick K. Knowlton
George W. Knowlton, Jr.
Percy E. Landolt
Robert LeRoy
Charles E. McQuigg
Edgar L. Maxwell
James W. Mills
Edmund T. D. Myers, Jr.
John J. O'Connell
John M. Parker
Henry Pollard
Weaver H. Rogers
Thomas S. Schultz
Alexander W. Smith
John S. Spicer
Rush Sturges
Waitstill H. Swenarton
Herman L. Wittstein
Joseph H. Zerbey, Jr.
Captains—
Philip L. Alger
Harold D. Ashton
Myron C. Ballenberg
Charles K. Bassett
Eugene G. Blackford
Lorn Campbell, Jr.
Ossian L. Cook
Loving T. Cruteher
George H. Eggleston
Michael T. Fullan
Paul W. Gaebelein
Edward R. Glenn
Robert F. Hunt
Francis L. Hutsler
Charles A. Jones
Frank C. Jones, Jr.
John Kearney
Robert C. Kinney
Harry N. Knowlton
Robert B. Litchfield
Frederick C. McCormick
George B. Mansur
Carl T. Naumburg
Frank O. Parker
William R. Patterson

James B. Ramage
Henry B. Reardon, Jr.
Maurice F. Roche
Jacob W. Sands
Henry L. Slade, Jr.
Alexander M. Stewart
George C. Tenney
Frederick E. Townsend
Albert C. Wilbur
Harold J. Williams
Stanley H. Wolcott

First Lieutenants—
Charles W. Almstead
Hollis S. Beatty
Paul Billingsley
Fred A. Clark
John T. Haugaard, Jr.
Daniel I. Hayes
Barton V. Hilliard
Spurgeon W. Howatt
Edward B. Luitwieler
Robert R. Moodey
Eben F. Oliver
Edward E. Petri
James J. Purcell
Harry B. Robinson
William Schuneke, Jr.
George C. Sedley-Brown
Thomas J. Sheftall
Graham Starr
Rene P. Thalmann
Frank D. Wilson

Second Lieutenants—
Albert C. Andrews
Talmage D. Auble
Ralph F. Bagley
Hal D. Balyeat
Charles F. Becher
William Benninger
George W. Bingham
Arthur P. Bliss
John W. Bloodgood
Edward S. Bristol
John M. Burns
John E. Canning
Emmett B. Carmichael
Hiram B. Channon
Herman Cohen
Joseph E. Dorais
Franklin G. Dunham
Arthur A. Dunkel
Claude L. Eubank
Walter R. Faries
Edwin C. Foltz
James L. Foster
Roger C. Gipe
Jesse J. Glick
Edward I. Gutel
Earl V. Guy
Victor H. Halperin
Louis H. Hibbitts
James A. Hickey
Thomas W. Hurley
Earl E. Johnson
Frederick A. Keating
Herbert Kranich
Benjamin C. Kreiner
Charles L. Leeper
Theodore E. Look
Paul C. McGilliard
Donald B. Mehaffey
Sol W. Moiselle
William L. Mong
Alfred E. Munch, Jr.
Seth E. Pool
Christopher A. Ray
Lewis Rehr
Frank M. Rhatigan
William M. Riach
Walter E. Rossbach
Franklin E. Smith
Aloys H. Sprick
Floyd S. Sutherland
Asher W. Taylor
Harrison M. Thomas
Lloyd F. Weaver
Fred H. Whitehouse
Harold S. Young
Oscar E. Zabel

Ammunition Supply

The Ammunition Supply Division, Office of the Chief of Ordnance, has prepared a series of twelve articles covering mainly ammunition supply functions for officers assigned to ammunition depots, ammunition companies or duties involving the handling of ammunition.

These articles are being sent out monthly to Corps Area Ordnance Officers for reserve officers of the T. A. Group and by local station commanders for Ordnance reserve officers of the B. A. Group assigned to ammunition duty.

The following is a list of articles, with the date of publication, which have already been sent out:

"Memorandum for Reserve Officers of the Ordnance Department assigned to Ammunition Supply Activities"—July 1, 1924;

"Ammunition Supply in Time of Peace"—August 1, 1924;

"The Storage of Ammunition and Explosives"—September 1, 1924.

Every Ordnance Reserve Officer should be a Member

of the

Army Ordnance Association

ELIGIBILITY

All men who are American citizens and who are interested in promoting the cause of industrial preparedness, particularly in connection with the design, procurement, production, manufacture, inspection, test or supply of Ordnance material.

Date.....

THE SECRETARY

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Book Reviews

The Naval History of the World War (Offensive Operations, 1914-1915). By Thomas G. Frothingham, Captain, U. S. R. Boston: Harvard University Press. 349 pages. Price, $3.75.

The flood of so-called histories appearing since the World War which have been tainted with the obvious purpose of winning a controversy, justifying a course of action, or getting first hold on public opinion without waiting to assemble and thoroughly digest facts, has led —on our part at least—to a fervent longing for the bespectacled historian of former days, who would delve interminably rather than make a single inaccurate statement and whose proof of authenticity was not the categorical denial of the claims of others, but the fact that his name appeared on the title page. That these near-histories should exist is perhaps but natural, for it was exactly seventy years after the beginning of hostilities that the first really dispassionate account of the Naval War of 1812 appeared and Theodore Roosevelt's history replaced the bitter rancor of the British historian, James, and the biased flag-waving of the American historian, Cooper.

It is with a feeling of relief, then, that we turn to The Naval History of the World War, by Capt. Frothingham, and find that he has dropped the controversial tone which is somewhat in evidence in his "True Account of the Battle of Jutland" and has taken pains to present an array of facts in interesting narrative form, freely interspersed with instructive comments and opinions.

The first two chapters deal with the general considerations which must form the groundwork on which any survey of the naval aspects of the war must be based and, while the professional reader might think some of the points are repeated too often, this form of emphasis is ideal to indoctrinate the general reader and prepare him for a ready appraisal of the events which follow.

These events are well grouped in chapters that lead the reader easily from the first "on guard" moves, through the wax and wane of cruiser warfare in distant waters, the tentative thrusts of both sides in home waters and the final defeat of the naval attacks on the Dardanelles. Frequent reference is made to both the British official historian, Corbett, and the official German book, "The War at Sea." Both these authorities came into being too near the end of the war to be absolutely above suspicion, but they nevertheless bear official status and are supported by at least local proof. They must be relied upon as the best evidence obtainable for a long time to come.

What appears to be the author's main original contribution is his analogy between the development of the Federal blockade during our Civil War and the development of the World War from a conflict between armed forces to a conflict between whole populations. In only one instance does the author abandon his role of a relator of facts, when, in discussing the naval raids on Scarborough and Hartlepool, he says of these towns, "they were not 'fortified' in the sense of having any works worth destroying." This savors of evasion and it were better to have listed the defensive works or to have investigated to the point of being able to say that the towns were not fortified.

The moral effect of various naval exploits on the vacillating Turks and the diplomatic situation in Constantinople, is set forth in detail and the sins of omission and commission on the part of the Allies, particularly the British, are commented on at length. It would have completed the tale to have mentioned the fact that the Sydney, after destroying the Emden, failed to capture the Emden's landing party, because when this party, long considered lost, suddenly appeared in Constantinople, the rejoicing was out of all proportion to the nominal importance of the incident and must have heartened the impressionable Turks to an appreciable extent.

We cannot but feel that the author's stern arraignment of everything connected with the Dardanelles expedition, from its inception through all its naval phases, is a reflection of the avenging Report of the Dardanelles Commission (which is often referred to) and the mere fact that the expedition actually failed. The Dardanelles Commission met while the British public still felt the blight caused by the loss of well over ninety thousand men and many ships, for no vestige of gain of any kind. It is safe to say that, had the expedition succeeded, the naval experts would have pointed out that their astute leaders had early learned the lesson taught by the quick reduction of the Belgian forts by overwhelming indirect fire and applied it to naval action against forts, thus demonstrating that the naval lessons of our Civil War belonged to the age of early ironclads and smoothbores. As it is, those same leaders paid the penalty for failure, but it is devoutly hoped that the final historical verdict will not be that there was absolutely no justification for the idea, unfortunate as the final outcome may have been.

Captain Frothingham's work as a whole is not so fervid as Maclay's History of the Navy, but reads as smoothly as Barnes' Naval Actions of the War of 1812 and deserves a high place among the more important naval annals. Its complete index makes it of value to the investigator as well as to the general reader. We look forward with pleasure to the succeeding volumes.

These Eventful Years. The Twentieth Century in the Making, as told by Many of Its Makers. New York: Encyclopædia Britannica, Inc. 1924. Vol. I, XXI, 692 pages; Vol. II, XII, 695 pages. $11.50.

This monumental work has as its object "to tell what has happened in the years of this century, where the world stands to-day, and what the outlook (is) for the future." Its eighty-four chapters deal with subjects as diverse as "The Causes of the World War," "The Inter-Allied Debts," "The New Poetry," the "Antiquity of Man in Middle America," "Psychoanalysis" and "Modern Religious Tendencies." Each chapter comes from the

pen of an acknowledged authority on the subject of the chapter. Among those who contribute are men of such varied activities as Major Generals Maurice and Ludendorf, Admirals Sims and Von Tirpitz, Bernard Baruch and H. G. Wells, Charles M. Schwab and Sir Oliver Lodge.

Naturally the events directly and indirectly connected with the World War occupy a preponderating amount of the space at the editor's disposal. Somewhat more than one-fourth of the first volume is directed to a "History of Our Own Times," in four chapters by J. L. Garvin of the *London Observer*. This is followed by a number of chapters relating to the war. These are by men from both sides and no attempt has been made to reconcile irreconcilable new points. General Maurice tells how the war was won and General Ludendorf maintains that Germany was never defeated. Admiral Jellicoe presents the British side of the Battle of Jutland and Admiral Sheer gives a divergent account of the same actions from the German standpoint.

The present day economic situation receives attention from Professors Laughlin, Seligman, Austin and Bowley. Attention is next shifted to the various national situations—among the chapters devoted to national matters are "Ireland's Problems" by Sir Horace Plunkett, "The United States Becomes a World Power" by John H. Latane, "Dynamic Italy" by Ex-Premier Nitti, "Germany's Place in the Sun" by Maximilian Harden, etc.

The series devoted to the affairs of individual nations is interrupted by a chapter by H. G. Wells attempting a "Forecast of the World's Affairs," which introduces the second volume. Literature, Drama, Music, Science, Archæology, Psychoanalysis, Education, Religion, Business, Prohibiton, Commerce and other subjects find a place in the text. While the volumes are in no way intended to be encyclopædic, they offer a large amount of very fascinating reading on a wide range of subjects which are of the greatest importance in the world to-day. The general reader will find them a valuable addition to his library; the specialist will find them a source of additional inspiration and guidance.

The True Story of Woodrow Wilson. By David Lawrence. New York: The George H. Doran Company. 1924. 368 pages. $2.50.

Each new biography of Woodrow Wilson differs from its predecessor in two principal aspects: the qualifications of the biographer and the viewpoint in which he interprets the various activities of his subject. Thus, fact for fact, there is really very little difference between Tumulty, Daniels, Annin and Lawrence—the principal facts are recorded in each, the interpretations vary. But this is an attribute of all histories from which it would be futile to expect our late war president to escape. True, Mr. Lawrence gives certain sidelights that are not to be found elsewhere—but so also do the others.

For all that, Mr. Lawrence's work is different from each of its forerunners. Tumulty is the worshipper; Annin, the iconoclast; Daniels, the admirer; and Lawrence, the impartial Boswell, ready to praise where praise is due, and to criticise when proper.

The name of David Lawrence needs no elaboration. A student at Princeton when Dr. Wilson was President of the University, he covered the illustrious leader in that capacity, through the Governorship of New Jersey, the Presidency of the United States, the Peace Negotiator, and on to the very end of that famous career. His contact with the President was most intimate and he has narrated his story in a fearless and impartial way. So much so that after reading the book one must conclude that the author has performed well the arduous task he undertook.

He says in the foreword: "The writer has never identified himself with either the Republican or the Democratic Party and intends this work for no other purpose than to serve as a dispassionate record from which the reader may draw his own conclusions." And this task is faithfully performed.

Here then is a book that will mean just what its name implies—a book replete with interesting data much of which has not been written before—a book which is at once a constructive piece of literature which the readers of today and more especially those of tomorrow will appraise highly—a *true* story of Woodrow Wilson.

The History of the United States Army. Major William A. Ganoe. New York: D. Appleton & Company. xi+609 pages. $5.00.

This work is unique in that for the first time an attempt has been made to "tell a plain, straightforward story of those of our own people who have answered our country's voice in its many calls for help and protection." In short, it is the first history of the United States Army ever published. Major Ganoe has approached the task with an experience and training which has fitted him for the task as perhaps few others have ever been. He treats his subject with a refreshing directness and a frankness and terseness of statement which well befits the professional soldier.

The treatment is chiefly chronological. Any other method of approach would have been obviously impracticable. Indeed, it is a matter of surprise to discover that the Army has had so much history of a purely chronological sort—campaigns and battles; organizations and reorganizations; changes in policies, methods of training and equipment—which could not be omitted from mention and leave the work complete. The author has exercised a sound discretion in his choice of material and the relative emphasis which he has given events.

Beginning with an account of the election by the Continental Congress of George Washington as Commander in Chief of the Continental Army and his assumption of command at Cambridge on July 3, 1775, the story is carried through the Revolution, the second war with Great Britain, the Mexican War, the Rebellion, our Indian wars, the Spanish-American War and the World War to the reorganization under the Act of June, 1920. A few extracts will serve to illustrate the style:

"Nowhere in the history of the Revolution did our lawmakers intimate by the slightest token that there existed such a thing as military technic or efficiency. Family, caste, friendship, favor and politics seemed to be the determining factors in awarding splendid commissions. Arnold, the most brilliant divisional commander of the war, was passed over time after time by incompetents until he finally responded to ill treatment with treason."

"His musket was old and too often useless. The Springfield Arsenal was the only service manufactory of small arms in the United States, and its output only 200 a month. The Confederates had scooped from the arsenals of the South, thanks to Mr. Floyd, 235,000 muskets, so that they were well armed at the outset. But the Federals were so ill-provided that even flintlocks were issued. Few rifles found their way into the hands of the volunteer. The markets of Europe were scoured for any kind of weapon. The result was that they purchased *any kind* at a high price, and the volunteer suffered accord-

ingly. The calibers under such improvidence were as varied as in the Revolution. Few soldiers could use each other's ammunition. Old English Enfields, German and Belgium smoothbores and American arms of many makes and sizes were distributed to the commands. Some companies had only enough good weapons for the performance of guard duty."

"This, being a history may not argue: it only records. But the facts recited from 1775 to 1923 seem to clarify at least one point. When we were strongly disciplined, trained and well organized, we gained a quick peace. When we were not so constituted, we lost lives and money fruitlessly. It was not war of itself that brought so much horror to our people, as did our comfortable sleep in the intervals of quiet."

Now that our country at last has a definite military policy imbedded in statutory law by Act of Congress, this book will fill a clearly defined need for soldiers of all three components of our Army—the Regular, the National Guardsmen and the Reservist—and afford them an opportunity to acquire that historical background without which they cannot have the proper military perspective. The general reader also will find in it an authoritative and eminently readable account of an important and frequently little appreciated instrument which has rendered yeoman service helping our country achieve her present national unity and international status as one of the great powers of the world.

The Dissertation on the Sovereignty of the Sea. By Cornelius van Bynkershoek. A photographic reproduction of the Second Edition (1744) with an English translation by Ralph Van Deman Magoffin, and an Introduction by James Brown Scott. New York: Oxford University Press. 1923. 188 pages. $2.00.

To van Bynkershoek's treatise *De Dominio Maris Dissertatio* the student of international affairs needs no introduction. Little of new praise of it can be said now that has not already been said. It is a classic and will ever remain so. But the presentation of this important work in the photographic fac-simile of the Latin original together with the superb translation of Professor Magoffin and the scholarly introduction by Dr. Scott, make up a monumental work.

This publication is No. 11 of the series of classic works connected with the history and development of international law gotten out by the Carnegie Endowment for International Peace.

Bynkershoek's well-known thesis holds—contrary to Grotius—that the sea beyond cannon shot from the shore (the well known three mile limit) is subject to occupation and ownership even though it has not been so occupied and owned and that a state can hold the waters washing its shores by cannon shot from the shore. This doctrine he asserts when he says: "Wherefore on the whole it seems a better rule that the control of the land (over is as far as we seem to have both command and possesthe sea) extends so far as cannon will carry; for that sion." Thus the author was sufficiently wise to permit of future modification when he says: "I am speaking, however, of our own times, in which we use those engines of war, otherwise I should have to say in general terms that the control from the land ends where the power of man's weapons ends, for it is this, as we have said, that guarantees possession." The recent treaty modification of the former law in accordance with the holding of this eminent writer makes this analytic forecasting all the more interesting at this time.

Man Power in Industry. By Edward S. Cowdrick. New York: Henry Holt & Company. 388 pages. Price, $3.25.

As a contribution to the literature of industrial relations this book is to be welcomed. It is a well balanced and fair minded presentation of the relations between the management and the man. While a consensus of opinion is not to be expected on a subject as complex and controversial as the author's, the opinions expressed seem to be sane and well substantiated by his experience.

Among the questions discussed are hiring, psychological tests, mediation and arbitration, employee representation, training employees, accident prevention and workmen's compensation, welfare activities, etc. The wide scope of the text prevents a detailed treatment of the subjects included, but each chapter is followed by a list of references which will be of benefit to those desiring more complete information.

Chats on Science. By Edwin E. Slosson. 273 pages. The Century Co., New York and London. Price, $2.00.

Dr. Slosson is probably as well known to the general public as he is esteemed in scientific circles. His widely published articles as director of Science Service and his entertaining talks over the radio as well as his first book, "Creative Chemistry," have done much to put scientific facts in a form to arouse the interest of the layman. His ability to discuss science, without the use of unintelligible statements, involved phraseology and mathematical formulas, is remarkable.

"Chats on Science" includes 85 "short stories" full of scientific facts on all manner of subjects, philosophy, wit and humor. The reader need not mark his place when he lays the book aside, as he may reopen it again at random and find a story as interesting as the one he left. It is indeed "a book to be read for entertainment,—the profit will take care of itself."

Practical Mathematical Analysis. By H. Von Sanden, Professor of Mathematics at the University of Clausthel. Translated by H. Levy, M.A., D.Sc., F.R.S.E., Professor of Mathematics, Imperial College of Science and Technology, London. New York: E. P. Dutton & Co. 194 pp. Price, $4.50.

Before the World War German books on technical and scientific subjects were very much in demand in American research laboratories and institutions of learning. Since that date the demand in the English speaking nations for German books has, as was to be expected, been small, and few English translations have appeared. There are many who feel that this is exceedingly unfortunate since many German books have been published which could be used to advantage by other nations. It is with this feeling, no doubt, that H. Levy, Professor of Mathematics at the Imperial College of Science and Technology at London, has seen fit to translate this practical treatise of mathematical analysis.

This treatise is essentially of higher mathematics and will be found useful only to those who have the basic understanding of logarithms and calculus. With this understanding, however, little trouble will be found following the various processes of reasoning.

One of the author's aims is to develop confidence in the mathematician. Face to face with a special problem, a student is often at a loss how to begin or what procedure to follow, and even after the decision is made and the problem solved there is the inevitable feeling that

perhaps the solution is not correct. Here the author gives excellent advice on the choice of methods and strengthens the computer's confidence in the method by making clear to him just what steps are being taken and what each step means in the solution.

The following example of the use of the slide rule in multiplication will serve as an illustration of the practicability of the text. Suppose it is desired to square the quantity .000321. In order to avoid errors in the decimal point the author suggests the quantity be written 3.21×10^{-4} which can be squared without confusion,—i. e. $(3.21 \times 10^{-4})^2 = 10.27 \times 10^{-8}$. Hints of this nature, while simple, are an invaluable aid to rapid, accurate computing.

The subjects treated include: the slide rule; the calculating machine; rational integral functions, and their extrapolation and interpolation; arbitrary functions and their interpolation; numerical differentiation and integration; mechanical quadrature; integration and differentiation by graphics; analytical approximation to empirical functions; solution of equations, linear, transcendental and non-linear; integration, graphical and numerical, of functions; solution of equations linear, transcendental higher orders.

Representative Government in Industry. By James Myers. New York: George H. Doran Co. 249 pages. $2.00

As long as human beings occupy the relative positions of managers and workers, there will be differences to be adjusted between the management and the workers. With the gradual development of the science of management, more and more attention is being given the subject of industrial relations and many schemes are being tried out which purport to give the operatives a share in the management. One of the most successful of these has been adopted by the Dutchess Bleachery, Inc., of Wappingers Falls, N. Y. The author of this book is Executive Secretary of the Board of Operatives of the above company and as such has had valuable personal experience in the application of his subject.

The book is a general philosophical study of the subject and reflects very clearly the operatives' point of view. Indeed it is this fact which gives the study its chief value. Any management contemplating the question of industrial relations has no difficulty in getting the managerial point of view, but it is not easy to discover how the men look at it. Doubtless there is much in the work with which many employers will be in disagreement—certainly a large portion of them will not agree that organized labor is discriminated against by open shops which refuse to deal with unions as such—but it is important that employers know the attitude of the employed and for this reason their perusal of this book will be of value to them.

Dynamic Flight of Projectiles. By Arnold L. Chevallier. London: Syndicate Publishing Co., Ltd. 208 pages.

The title of this book implies a technical discussion on the action of a projectile during its flight. The work, however, is merely an attack upon existing ballistic theories and particularly upon the British Ordnance Service for failure to properly recognize the advantages of the "L. T." (Leslie Taylor) system of projectile design.

The exact connection of the author with the so-called L. T. system is not revealed and there is no method of determining how faithfully the author has presented the views of the inventor.

The line of thought is difficult to follow, due to the author's fondness for using large and unusual words where simple words would fully express the thought. Furthermore, the 208 pages are divided into forty chapters and fifty-nine appendices with a larger number of footnotes, which tend to distract the readers attention rather than to add to the clarity. The various chapters follow some sequence of thought but the appendices cover a large number of non-related subjects, such as giving the true story (probably one of hundreds) of Napoleon's rejection of a breech loading rifle submitted to him, criticism of certain breech mechanisms used by the British Service, suggesting sighting systems, etc., and in one place, stopping abruptly to pay his respects to the memory of a Captain Thomas from whose lips he once obtained a detailed account of the action of a shore battery. The changes of subject matter are made with such frequence and with such abruptness that it appears as if there might have been a design to distract the reader's mind from following too closely his discussion of the L. T. system, for which very extravagant claims are made but few facts, either in the way of experimental data or mathematical proofs, are offered. In fact, the author openly states his contempt for the mathematical formulae deduced by ballisticians.

As near as can be deduced from the mass of words, the author claims that Leslie B. Taylor has devised a new type of projectile which upsets all present ballistic formulae. He practically eliminates from the present ballistic coefficient the factors of weight and form and substitutes one of which he refers to as the stability factor. He also adds a kiting effect. By stability he means that the axis remains parallel to its original line of projection throughout the trajectory. He claims to accomplish this by concentrating the mass to the rear and towards the outer walls, the purpose being to bring the center of gravity to the center of the figure and concentrate the mass so as to obtain large energy of spin with very moderate angle of twist.

The experimental work appears to have been confined to sporting rifles and the results confirmed by some spinning tests with a rotascope or top in which the mass could be moved forward and back along the axis by means of a screw. He determined that when the mass was concentrated at the rear the top would spin longer than when it was concentrated near the point and, as length of spin was considered as a direct function of ranging power, the design was fully proved. There appeared to be no question in his mind as to whether the results obtained with a projectile spinning on its point would be applicable to one moving through the air where the point of suspension might be considered as located at the center of mass rather than at the point. He made another wonderful discovery by spinning this top and that by giving it a half turn between the thumb and finger it could be made to spin for three minutes if the mass were properly placed, and as three minutes is sufficient for any projectile, you have your proper twist of rifling, namely a half rotation in the bore instead of a full rotation or more as at present.

The author devotes much space to the question of spin. He claims in effect that the power of guns as now constructed is limited solely on account of the fact that further increase in length of barrel would not result in increased linear velocity because the energy would be

entirely absorbed in producing spin. He claims the useful length of a field gun is now limited to about 32 calibers and of a naval gun to about 50 calibers on this account. If it were not for his contempt for a little simple mathematics, he could readily have determined that the rotational energy now imparted is too small to have any appreciable effect on the linear velocity (about .6 percent of the total energy for a 16-inch 50-caliber gun). He could also have demonstrated that a half turn in the bore was meaningless because the spin acquired in that distance would be dependent upon the linear acceleration. As proof for his statement that spin absorbs a large part of the energy, he contents himself with the statement that he once met a man who claims to have seen a projectile fired through a barrel, where it landed just in front of the muzzle, due to excessive spin.

The main point of his discussion, however, centers around the German long range gun which he claims is directly based upon the L. T. system. The claim is based upon type of projectile which has a short body with a long hollow cowl or ogive, which results in concentrating the mass well to the rear. The use of the long cowl is explained as not being for the purpose of improving the form but to increase the angle of restitution and to increase the size without increase in weight so as to obtain greater kiting effect which he now claims to have an important effect. He compares the action with an aeroplane, without, however, mentioning the difference in mass-displacement relations. Considerable effort is required to harmonize the German adaptation of the L. T. system to the long range gun while adhering to the conventional system in the remaining guns including the small arms bullet known as the Spitz, which the author states is one of the worst examples. He also attempts to explain the fact that German ballisticians, such as Cranz, adhere to the ballistic formulae wherein sectional density and form are the basis rather than stability and kiting effect. On the whole, nothing is brought out which indicates that Rausenberger ever heard of the L. T. theory.

The foregoing indicates the small technical value of the book. At one place he views with alarm the loss in spin of an ordinary projectile, quoting Bethel; at another place he views with equal alarm the statment that an ordinary bullet loses linear velocity faster than spin. He builds up what he considers a definite connection of the German "Big Bertha" by giving the supposed elements of the projectile and then the elements of the gun, such as 100 calibers long, made possible by the small angle of twist, with a resultant linear velocity of about 5,000 feet per second. He repeatedly gives the spin of this gun as one turn in fifty calibers and at the same time gives the angle of the ribs on the projectile as about 2 degrees—not being at all concerned that the two figures are entirely inconsistent. The claims, moreover, are decidedly exaggerated and fail to harmonize. He definitely claims that a projectile of the L. T. type will range at least three times as far as one of ordinary type. This would give almost any larger 50-caliber gun as great a range as the "Big Bertha" without any other new feature. He also claims that reduction in pitch of rifling greatly increases the linear velocity with the same breech pressure. This change then should have been ample without increasing the length of gun to 100 calibers. With the 5,000 f/s velocity and the L. T. projectile, much greater range should have been obtained. He also claims about 8 percent of the velocity acquired was due to gas action after the projectile left the muzzle. This amounts to over 25 percent of the energy. He then later states that in order to eliminate the disturbing effect of the blast action the gases were probably released by radial vents before the projectile reached the muzzle.

Stripped of the extravagant claims there is nothing so particularly novel about the L. T. projectile. It is the present practice to concentrate the mass of artillery projectiles as far as practical into the body of the projectile. The main difference is that the author subordinates all tactical considerations to obtaining just the desired distribution of mass for ranging purposes, whereas the ordnance engineer strikes a proper balance between the various requirements, probably placing effect at the target first. The author admits he has never considered how the bursting charge of a high explosive shell could be placed nor how the armor-piercing qualities of a naval projectile could be obtained but believes that the ordnance engineer can solve those problems. The shape of the point of the L. T. projectile, as exemplified by the German long range type, is not unlike that of the modern conventional projectile, the only dispute being as to the function of this point. There is no reason for believing that the L. T. projectile remains stable as described by the author, nor is it desirable that a projectile should so travel, particularly for high angle fire required for long range. An American naval officer, Captain C., questions the penetrating characteristics of a projectile whose line of motion is at an angle to the axis. The author defends the action by stating that the trajectory will be flatter and the striking velocity higher, entirely missing the point as to the line of motion, being possibly at right angles to the axis. The flight of a projectile at long range and its ability to penetrate armor appear to be much debated questions. A certain American inventor, quite as strenuous in his criticism of the existing order in America as the author is of British regime, claims that all projectiles travel with the axis parallel to the original line of projection and therefore armor penetration cannot possibly be obtained under any conditions, so it is hardly to be wondered at if the ordnance engineer is frequently skeptical of new theories which are claimed to entirely upset the existing system.

As a technical work on exterior ballistics, the "Dynamic Flight of Projectiles" depends too much for its statements of fact upon, "I once met a man who claims to have seen."

The Chemical Resistance of Engineering Materials. By M. L. Hamlin and F. M. Turner, Jr. New York: Chemical Catalog Company, Inc. 1923. 267 pages Price $5.00.

Engineers with no previous chemical experience who, in the period 1915-1918 were called upon to build chemical plants, were greatly handicapped by the lack of much necessary information in a readily accessible form. No collection of data on the action of chemical construction and other enineering materials was available and not even a comprehensive bibliography existed to serve as a guide to the literature on the subject. The volume in hand fills this need. The object of the authors of "The Chemical Resistance of Engineering Materials" is to present this very information in a full, yet not exhaustive, manner and wherever possible to give quantitive data.

The introduction to the book includes a discussion of the influence of agitation and electrolytic action on the corrosive tendencies of chemical liquors. First considera-

tion is given, quite properly, to sulphuric acid. The chapter entitled, "Sulphuric Acid and Metals" covers 35 pages. The chapter on "Other Acids and Metals" is devoted largely to the general subject of corrosion. Under the heading "Acids and non-metallic materials" the following substances are considered: concrete and cement, bricks, tiles and stone-ware, glass, fused silica, enamels, wood, cotton, wool, silk, hair cloth, rubber, acid-proof cements and Trinidad asphalt. Then follow chapters on bases, alkaline salts and neutral substances.

The chapter on "Selection of Material for Specific Equipment" contains tables of materials for evaporators, materials for pumps and a discussion of the comparative efficiency of laboratory-top materials. It should be especially useful to engineers. The chapter on concrete contains much information concerning protective coatings.

At the end of each chapter is a bibliography, while in the 68-page Appendix are given tables of physical constants and of the physical properties of materials—most of which are not usually available in engineering handbooks. This book should prove very helpful to chemical engineers.

Sea Power in Ancient History. By Arthur MacCartney Shepard, with a foreword by Rear Admiral William A. Moffett, U. S. N. Boston: Little, Brown and Company. 286 pages. With illustrations, maps and plans. Price $5.00.

There is a fascination about early Greece and Rome which always assures an author writing capably of their history a large and interested group of readers. Mr. Shepard therefore chose an exceedingly popular subject and one destined to win public approval when he wrote this story of the navies of classic Greece and Rome. From the ancient writings of Thucydides, Xenophon, Polybius and other historians there has been gathered together an account of the earliest recorded naval battles down to the destruction of Roman sea power by the Vandals under the barbarian king Gaiseric. As the author has said, little has been written concerning this subject and yet sea power was probably the leading force of that age, if not of all ages, in moulding civilizatiion. It is decidedly free from the mass of general history with which the author could have filled the pages, and deals solely with naval affairs.

The naval problems confronting us today are to a marked degree the same as those confronting the peoples of by-gone days. Moreover there is a striking similarity in the navies themselves. While the chief means of propulsion was oars and the chief motive power was muscle and energy of hundreds of rowers, nevertheless it was not unusual to obtain speeds of 13 to 15 knots an hour for limited periods which speed compares favorably with the war ships of today. In order to provide room for the rowers, banks or tiers were superimposed one above the other and boats classified by the number of these banks. The trireme, or three banked ship, became the most popular, although in the Punic Wars ships with five and more banks may have predominated. The larger boats were, however, very difficult to handle. They could not avoid the rams of the enemy nor in turn ram them so successfully. Rowers were sometimes citizens, sometimes slaves, and usually severely disciplined. All of these things are fully discussed in the volume which makes the book educational as well as entertaining. The author also gives us excellent comparisons of the size and number of boats and the number of men engaged in battle. Lengths of ships were around 150 feet though some galleys exceeded 400 feet. It was not unusual for 500 or more triremes to engage in the same battle and to have aboard crews and marines totalling more than 100,000 men.

The account of naval warfare begins with the early Phœnician and Greek navies (1500 B. C. to 499 B. C.), follows the success of the Greeks in the Græco-Persian War, terminating in the battle of Salamis, and then turns to the internal rivalry of Sparta and Athens and the Peloponnesian wars. These wars are followed by an account of the defeat of Athenians by the Syracusans in the former's expedition to Sicily in the year 415 B. C. and the decline and fall of the Athenian sea empire. Here the scene shifts to Rome and the Punic wars and later to the battle of Actium in which Antony, almost wholly controlled by the beautiful but arrogant Cleopatra, was defeated, contributing to—if not actually causing the downfall of—the Roman empire.

The fact that Rear Admiral Moffett has written a foreword to this volume commenting favorably upon the text, is proof enough of its value. We can but agree with him that sea power has always been essential to progress and that Mr. Shepard narrates the influence of sea power on current history and civilization in a fascinating manner.

A History of Malta Knighthood. By W. Henry Lannin. Boston: The Four Seas Company. 10 chapters. 260 pages. Illustrated. $2.50.

About the year 1050 A. D., Jerusalem was in the hands of its Moslem conqueror, the Caliph of Cairo. Some Christian merchants of Amalfi, trading with the infidels, gained favor with the Caliph and obtained permission to build for the use of the ever increasing swarms of Christian pilgrims to the Holy Sepulchre a church and two hospitals within the city walls. One of the hospitals was dedicated to St. John the Almoner "who was neither the Evangelist nor the Baptist but a certain Cyprian (native of Cyprus) who had been Patriarch of Alexandria." This hospital was originally manned by peace-loving monks, but troublous times insensibly introduced bolder spirits who gradually militarized the hospital order until it emerged the "Knight Hospitallers of St. John" and looked to a more august patron, St. John the Baptist, for inspiration and guidance. The Knights of St. John, together with their rivals, the Knights of the Temple, were long noted as the bulwark of Christianity in those dreary epics of the Middle Ages, the Crusades, and exercised a profound influence on the civilization of an interesting period in the world's history.

A romantic organization of this type never lacks for chronicelers. The author has added to the literature on the subject a concise account of the origin of the Knights of St. John at Jerusalem, their part in the Crusades, their heroic defense of the Island of Cyprus against the Turks, and their final establishment at Malta as the Knights of Malta after the loss of Cyprus. The historical narrative reads like a novel, but one is rather disappointed to observe that the literary style leaves much to be desired when compared with Edward Gibbon's account of the same perid. The author unduly emphasizes the faults of the Latin Church during the Middle Ages but omits mention of the constructive role of this institution in the civilization of a savage period.

To the student of history desiring a short account of the rise, development, and activities of one of the great knightly orders of the Middle Ages, this book may be recommended.

Recent Patents

Brief Descriptions of Inventions of Interest to Ordnance Engineers

Compiled by W. N. Roach, Chief, Patent Section, Office of the Chief of Ordnance

INVENTIONS in Ordnance and its allied arts, while not as numerous as during the period of the war and a few years immediately succeeding, are still being produced to a considerable extent, and patents of more or less worth are being issued thereon. Some of the recent United States patents are listed below.

Ammunition

Reissue patent No. 15,882, granted under the Act of March 3, 1921, commonly known as the Nolan Act, has been granted July 29, 1924, to V. Schlafer, assignor to Fried Krupp Aktiengesellschaft, for a percussion fuze. In this fuze a rammer, or firing pin, and striker, or plunger, are placed in sequence and normally held apart by centrifugally operated members. The firing pin has a solid portion located within the body of the fuze and a crushable portion extending beyond the body and housed in a crushable cap or nose of the fuze. The striker or plunger carries the primer and is held spaced from the firing pin during flight and after arming by a light spring.

H. Safford, was granted patent No. 1,502,400, issued July 22, 1924, for an inflammable shell. This shell contains little of a novel character other than the particular way in which the bursting charge has been mounted in the removable cap of the shell. The main body of the shell contains the inflammable material.

Samuel Wiley, of Picatinney Arsenal, has been granted patent No. 1,500,214, issued July 8, 1924, for a projector. This is a simple device for projecting flares, signals and the like from airplanes. The device has a seat for the flare shell or cap, and a slide movable over the flare seat carrying a firing pin or plunger. When the firing pin has been operated and the slide drawn from over the seat the flare shell or cap is automatically released from the seat and drops by gravity free of the plane.

Patent No. 1,498,053 was granted June 17, 1924, to G. H. Mains and F. B. Stieg for a process for the comminuting of smokeless powder of the nitrocellulose type. The process was devised for the purpose of softening the grains of powder before comminuting so that less power may be needed and less danger experienced in comminuting. The powder is soaked in a solution of fufural, ethyl alcohol and water until the grains are thoroughly softened, then comminuted by grinding, beating, or extrusion. The comminuted powder is then washed in water and dried.

E. von Herz, was granted June 17, 1924, patent No. 1,498,001, for a process for the manufacture of a detonating composition for detonators or primers. The main objects of this invention are to render the heavy metal salts, such as lead azide, less sensitive to damp or air containing carbonic acid, more readily ignitable and stronger in compressed mass. In carrying out the process a solution of sodium azide and magnesim trinitroresoreinate is caused to flow slowly into a lead nitrate solution at a temperature of at least 60° C., slightly acidified with acetic acid, or, better still, lead trinitroresorcinate may be suspended in an aqueous lead acetate solution and a diluted solution of sodium azide allowed to flow in slowly at ordinary temperature.

Artillery

A. Barr and W. Stroud have been granted patent No. 1,496,253, issued June 3, 1924, for a range finder and height finder. The main object of the invention is to so mount the movable parts and to so contruct the operating mechanism thereof as not to impose any stress or strain on the frame during the operation of moving the movable parts. For this purpose special bearings are provided on the inner tube or optical frame of the instrument.

A patent on an infantry gun issued on July 8, 1924, to T. Lafitte, the patent being No. 1,500,711. The gun and its base resemble very closely the usual trench mortar structure, the base having a hemispherical socket, adapted to receive a spherical boss on the breech end of the cannon and a special screw device is provided on the base to engage with a screw pivoted on the cannon barrel for elevating the cannon and for giving it slight movement in traverse.

Patent No. 1,497,325, issued June 10, 1924, to P. J. Charbonnier for an extraction device for artillery. In this instance a spring operated extractor is used, the spring being cocked by the recoil and released when the breech is completely opened to extract the cartridge and the parts are returned to normal position by another spring which is also cocked by recoil.

Patent No. 1,497,763, for a gun was issued June 17, 1924, to E. Muller, assignor to the firm of Rheinische Metalwaaren-und Maschinefabrik of Dusseldorf-Derendorf, Germany. The patent covers heavy ordnance adapted for high angle fire which may be easily and readily swung to loading position. The gun and its cradles are mounted to swing about a pivot point so positioned as to be beyond the farthest point of recoil of the gun and the gun itself is trunnioned in the cradles at its center of gravity, so that when the gun and cradles are swung on the pivot point to the elevated position the gun may then be swung independently about its trunnions to the loading position.

O. D. Lucas, assignor to Vickers, Ltd., has been granted patent No. 1,502,259, issued July 22, 1924, for a percussive firing mechanism for breech-loading guns. This mechanism is intended primarily for use with signalling guns. This firing mechanism consists of a hammer which normally occupies a position some distance behind the firing pin, a sear for holding the hammer in position and

a movable firing member which operates upon the hammer through means of a firing spring and which at a predetermined point in its movement disengages the sear from the hammer to permit the latter to be impelled forward by the energized spring and strike the firing pin. A similar spring operated upon by the firing member is provided for returning this member and hammer to their original position when the said member is released.

E. Rimailho, assignor to Compagnie des Forges & Acieries de la Marine & D'Homecourt of Paris, France, has been granted patent No. 1,502,320, issued July 22, 1924, for an equilibrating device. The main object of the invention is the provision of an equilibrator which requires no extra casing and which forms no outwardly projecting members on the gun carriage; to this end a leaf spring is provided, one end of which is anchored to the gun carriage, the other end of which is connected by means of a connecting rod to a crank arm secured to the trunnions.

Small Arms

F. Feederle, assignor to Waffenfabrik Mauser, has been granted No. 1, 496,337, issued June 3, 1924, for a magazine rifle of small caliber. The rifle has special means to permit quick insertion and extraction of the magazine and is also provided with a special safety device.

Patent No. 1,496,852, was issued June 10, 1924, to H. H. Hussey for a small arm. The inventor has provided a tongue and groove connection between the barrel and sighting rail, his idea being to provide a sighting rail which is not liable to become detached from the barrel.

Patent No. 1,497,096, was granted June 10, 1924, to J. Eriksen for a machine gun. The invention relates to gas operated guns, the main object is to provide a simple and strong breech mechanism for such guns.

E. H. Meden, assignor to American Gasaccumulator Company, has been granted patent No. 1,498,186, issued June 17, 1924, for a duplex trigger control device. The main object of the invention is to provide with a primary gun a trigger mechanism whereby other guns may be fired in unison with the primary gun or the guns may be fired in succession.

Capt. Walter T. Gorton of Springfield Armory, was granted patent No. 1,498,542, issued June 24, 1924, for a machine gun unit. This patent covers a sear slide which operates transversely of the gun and may be operated from either side of the gun.

Patent No. 1,500,293, issued July 8, 1924, to H. E. Winans for a fire arm. The inventor has provided a sighting rib formed of a heat-non-conducting material so as to avoid any interference of heat waves with the sighting of the fire arm when it has become heated from rapid firing.

M. Ferrero has been granted patent No. 1,500,580, issued July 8, 1924, for a magazine feeding device. The magazine forming the subject of this invention has an inner divided compartment mounted to tilt under spring pressure after the cartridges in one compartment have been fed to the rifle so that the other compartment will then be in position to feed its cartridges to the rifle. The cartridges are fed by the usual spring pressed followers.

J. W. French has been granted patent No. 1,501,446, issued July 15, 1924, for a fire arm. The invention consists in providing elevated sights on the fire arm for use in marching fire, so that the gun stock may be held under the right arm pit, the cartridge belt being strapped around the body instead of the waist with the supporting socket thereon located just below the right arm pit.

N. J. A. Galliot, assignor of one-half to G. H. L. G. Bory, was granted on July 22, 1924, patent No. 1,502,558, for a recoil absorbing means for fire arms. The inventor has made use of an ordinary type of deflector for gases issuing from the gun barrel and in conjunction therewith has provided an expansion chamber surrounding the gun barrel in which the deflected gases are allowed to expand and from which they may then escape without injurious effect upon the gun crew.

John M. Browning, has been granted patent No. 1,502,658, July 29, 1924, for a fire arm. The object of the invention is to provide a fire arm having a receiver which will permit the use of cartridges of various calibers. In this fire arm a special form of receiver is provided in which a special bushing may be inserted when the shorter cartridges or cartridges of smaller calibers are to be used.

J. T. Kewish, has been granted patent No. 1,502,676, issued July 29, 1924, for an automatic rifle. The main object of this invention seems to be the provision of breech mechanism of comparatively simple construction which receives its intial movement from explosion of the primer.

Chas. W. Stone, assignor to General Electric Company, was granted patent No. 1,502,925, issued July 29, 1924, for a projectile. The main object of the invention appears to be the provision of a bullet which will have greater penerating power without an increase in weight or muzzle velocity. The inventor provides a bullet with a core of comparatively hard and very heavy metal, such as tungsten and a jacket of softer, lighter metal such as aluminum.

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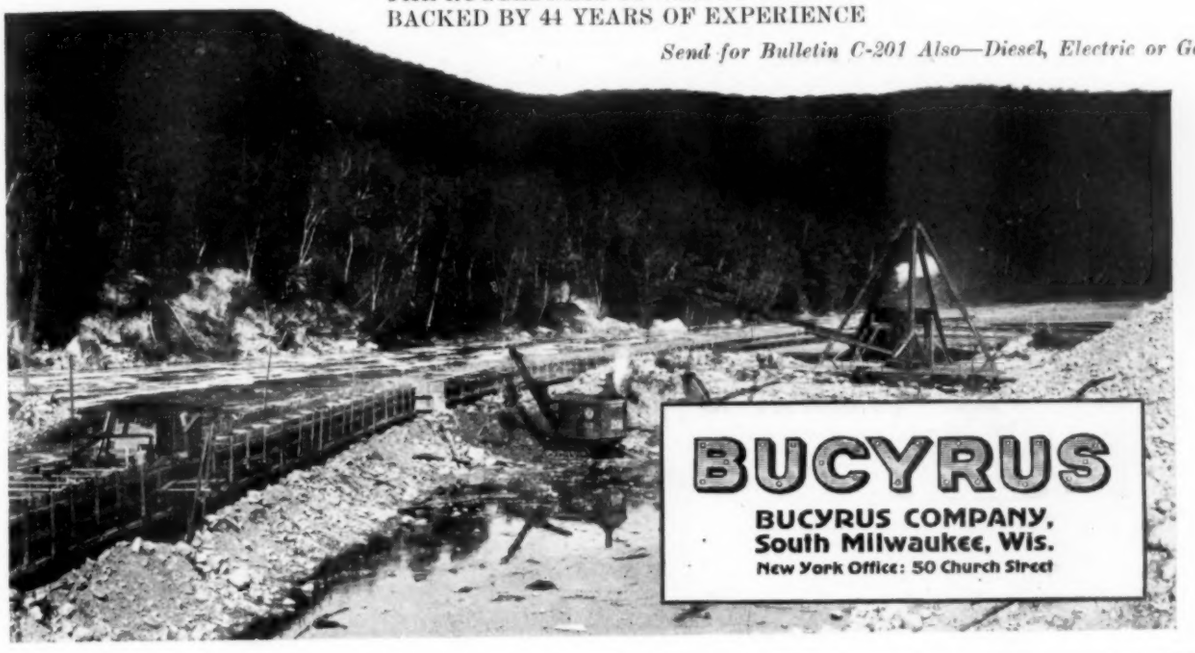

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